Town of Colma
COLMA, CALIFORNIA

Town of Colma – Campus Renovation and Addition

PROJECT MANUAL
VOLUME 2

AUGUST 14, 2017

Construction Documents - Infill

RATCLIFF

PROJECT MANUAL VOLUME 1

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS or
DIVISION 00 – INTRODUCTORY INFORMATION

00 01 10 Table of Contents
00 66 00 Substitution Request Form
00 72 13 General Conditions
00 73 13 Special Conditions

DIVISION 01 - GENERAL REQUIREMENTS

01 00 00 General Requirements
01 56 39 Tree Protection
01 81 13 Sustainable Design Requirements

DIVISION 02 - EXISTING CONDITIONS

02 40 00 Demolition
02 41 19 Selective Demolition

DIVISION 03 – CONCRETE

03 10 00 Concrete Forms and Accessories
03 20 00 Concrete Reinforcement
03 30 00 Cast-in-Place Concrete
03 33 00 Architectural Concrete

DIVISION 04 – MASONRY

04 27 31 Reinforced Unit Masonry
04 30 00 Stone

DIVISION 05 – METALS

05 05 23 User-Adhesive and Mechanical Fasteners
05 12 00 Structural Steel Framing
05 12 50 Architecturally Exposed Structural Steel
05 31 00 Steel Decking
05 40 00 Cold-Formed Metal Framing
05 50 00 Metal Fabrications
05 70 00 Decorative Metal

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 10 00 Rough Carpentry
06 10 53 Miscellaneous Rough Carpentry
06 16 00 Exterior Sheathing
06 20 23 Interior Finish Carpentry
06 41 00 Architectural Wood Casework

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 13 00 Sheet Waterproofing
07 14 13 Hot Fluid-Applied Rubberized Asphalt Waterproofing
07 21 13 Board Insulation
07 21 16 Blanket Insulation
07 26 20 Concrete Vapor Emission Control
07 27 26 Fluid-Applied Weather Barrier
07 32 13 Clay Roof Tiles
07 41 00 Metal Wall Panels
07 54 19 Polyvinyl-Chloride Roofing
07 62 00 Sheet Metal Flashing and Trim
07 71 00 Roof Specialties
07 76 00 Plaza Paver Systems
07 90 00 Joint Protection
07 95 00 Expansion Control

DIVISION 08 – OPENINGS

08 01 52 Wood Window and Door Rehabilitation and Replacement
08 12 14 Standard Steel Frames
08 13 14 Standard Steel Doors
08 14 13 Stile and Rail Wood Doors
08 14 16 Flush Wood Doors
08 31 13 Access Doors and Panels
08 33 23 Overhead Coiling Doors
08 41 13 Aluminum-Framed Windows and Storefronts
08 52 00 Wood Windows
08 71 00 Door Hardware
08 71 13 Automatic Door Operators
08 80 00 Glazing
08 83 00 Mirrors
08 91 00 Exterior Louvers

DIVISION 09 – FINISHES

09 21 16 Gypsum Board Assemblies
09 23 00 Italian Polished Plaster
09 24 00 Cement Plastering

09 24 90 Cement Plaster Repair
09 30 00 Ceramic Tiling
09 30 90 Tile Restoration
09 51 00 Suspended Panel Ceiling Systems
09 54 26 Linear Wood Grille Ceilings
09 65 00 Resilient Flooring
09 66 23 Precast Terrazzo Stairs
09 68 13 Tile Carpeting
09 68 16 Broadloom Carpeting
09 84 13 Fixed Sound-Absorptive Panels
09 90 00 Painting and Coating
09 96 00 High Performance Coatings
09 97 23 Concrete Dust Sealers

DIVISION 10 – SPECIALTIES

10 11 00 Visual Display Units
10 14 00 Signage
10 21 13 Toilet Compartments
10 26 00 Wall and Door Protection
10 28 00 Sanitary Accessories
10 44 00 Fire Protection Specialties

DIVISION 11 – EQUIPMENT

11 31 00 Residential Appliances

DIVISION 12 – FURNISHINGS

12 24 00 Window Shades

DIVISION 13 – SPECIAL CONSTRUCTION

DIVISION 14 – CONVEYING SYSTEMS

14 24 00 Hydraulic Elevator
14 42 16 Vertical Wheelchair Lift

PROJECT MANUAL VOLUME 2

DIVISION 21 – FIRE SUPPRESSION

21 13 00 Fire Sprinkler Suppression Systems

DIVISION 22 – PLUMBING

22 00 00 Plumbing Systems
22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment

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

23 00 00 HVAC Systems
23 05 00 Acceptance Requirements
23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment

DIVISION 26 – ELECTRICAL

26 05 00 Basic Electrical Requirements
26 05 48 Vibration and Seismic Controls for Electrical Systems
26 08 00 Testing
26 09 36 Modular Dimming Controls
26 24 00 Service and Distribution System
26 27 00 Basic Electrical Materials and Methods
26 32 14 Emergency Electric Generator
26 36 01 Automatic Transfer Switch
26 51 01 Lighting
26 56 01 Site Lighting
26 57 00 Low Voltage Lighting Control System

DIVISION 27 – COMMUNICATIONS

27 05 00 Common Work Results for Communications
27 05 26 Grounding and Bonding for Communications Systems
27 05 29 Hanger and Supports for Communications Systems
27 05 33 Conduits and Backboxes for Communications Systems
27 05 36 Cable Trays for Communications Systems
27 05 43 Underground Ducts and Raceways for Communications Systems
27 05 48 Noise and Vibration Controls for Communications Systems
27 05 53 Identification for Communications Systems
27 10 00 Structured Cabling Basic Materials and Methods
27 11 13 Communications Entrance Protection
27 11 16 Communications Cabinets, Racks, Frames and Enclosures
27 11 19 Communications Termination Blocks and Patch Panels
27 11 23 Communications Cable Management

27 11 26 Communications Rack Mounted Power Protection and Power Strips
27 14 00 Communications Outside Plant Backbone Cabling
27 15 00 Communications Horizontal Cabling
27 41 16 Audiovisual Systems
27 41 23 Communications Broadband Systems

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 05 00 Common Work Results for Electronic Safety and Security
28 05 26 Grounding and Bonding for Electronic Safety and Security
28 05 28 Pathways for Electronic Safety and Security
28 31 01 Fire Alarm System

DIVISION 31 – EARTHWORK

31 11 00 Clearing and Grubbing
31 13 00 Selective Tree Removal and Trimming
31 14 00 Earth Stripping and Stockpiling
31 23 00 Excavation and Fill
31 23 33 Trenching and Backfilling
31 25 00 Erosion and Sedimentation Controls
31 31 19 Vegetation Control

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 02 70 Crushed Rock
32 05 13.10 Soil for Bioretention Facilities
32 05 23 Cement and Concrete for Exterior Civil improvements
32 11 00 Base Courses
32 12 00 Flexible Paving
32 13 00 Rigid Paving
32 16 13 Concrete Curbs and Gutters
32 17 13 Parking Bumpers
32 17 23 Pavement Markings
32 17 26 Tactile Warning Surfaces
32 84 00 Irrigation
32 90 00 Planting

DIVISION 33 – UTILITIES

33 05 13 Manhole Grade Adjustment
33 05 16 Utility Structures
33 10 00 Water Utilities
33 30 00 Sanitary Sewerage Utilities
33 40 00 Storm Drainage Utilities
33 46 00 Subdrainage

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions, Supplementary Conditions, and Division 1 General Requirements apply to the work specified in this Section.

1.2 SUMMARY

A. Section includes: The work shall consist of complete design and furnishing all labor, material, and equipment required to complete the installation of the fire sprinkler systems as shown on the plumbing drawings and described herein, including all incidental work necessary to make it complete, satisfactory and ready for operation. Work shall include, but not be limited to, the following principal items:
   1. Provide a complete and functioning fire sprinkler system to serve the existing building and new building addition.
   2. Contractor shall submit shop drawings prepared by C16 licensed contractor for review and approval by the Local Fire Marshal's office for the fire sprinkler system.

1.3 RELATED WORK

A. Plumbing Systems, Section 22 00 00.
B. Heating, Ventilating and Air Conditioning Systems, Section 23 00 00.
C. Electrical connections to supervised equipment, Division 26.

1.4 GENERAL REQUIREMENTS

A. Published specifications, standards, tests, or recommended method of trade, industry, or governmental organizations apply to work of this Section where cited below:
   1. Title 19, State Fire Marshal – Public Safety
   2. Title 24, California Building and Fire Code (Parts 1-9 inclusive)
   3. NFPA 13, Installation of Fire Sprinkler Systems
   4. NFPA14, Standard for the Installation of Private Service Mains
   5. NFPA 25, Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems (with California Amendments)

B. Submittals: A complete list of materials and equipment proposed, accompanied by manufacturer's data sheets, giving sizes, capacities, etc., shall be submitted to the Architect in quintuplicate. The list shall include specified and/or substituted materials. No consideration will be given to partial or incomplete lists.

C. Examination of site: Examine site prior to bidding. Compare it with drawings and specifications. Check conditions and take measurements, which may affect work. No allowance shall subsequently be made for any extra expense due to failure to make such examination.

D. Drawings: Drawings indicate general arrangement of piping and equipment. Should it be necessary to deviate from arrangement or location indicated in order to meet architectural conditions or site conditions, or due to interference with work in other divisions, such deviations as offsets, rises, or drops in piping that may be necessary, whether shown or not, shall be made without additional cost to the Owner.

E. Manufacturer's directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and specifications. Where these are in conflict with drawings and specifications, notify Architect for clarifications before installing the work.

F. Codes: Work and materials shall be in full accordance with all applicable local or State ordinances, California Building Code, California Fire Code, local Fire Prevention Bureau, National Fire Protection Association, State of California Safety Orders, and State Fire Marshal. Whenever drawings and specifications require larger sizes or higher standards than are required by regulations, drawings and specifications govern. Whenever drawings or specifications require something, which will violate regulations, regulations govern. No extra charge will be paid for furnishing items required by regulations but not specified or shown on drawings.

G. Cooperation with other trades: Schedule work and cooperate with other divisions to avoid delays, interferences and unnecessary work, conforming to construction schedule, making installation when and where required. A special effort shall be made to coordinate with the mechanical contractor so as not to block installation of the mechanical systems. The clearances above ceilings on this project are extremely limited and the ductwork and mechanical equipment are to have the highest priority. All fire sprinkler work is to be coordinated with the mechanical contractor such that the ductwork and equipment can be installed in the locations shown on the mechanical drawings and the required equipment service access areas are kept free of obstructions. If installed work is later found to interfere with work of other divisions, make all necessary changes at Contractor's expense.

H. Licenses, permits, services, and fees: Secure and pay for all licenses required to begin, perform, and complete work. At completion of work, deliver to Owner, through Contractor, certificate of acceptance issued by jurisdictional authorities approving a complete fire sprinkler system.

I. Quietness of operation: Adjust, repair, or replace any equipment producing objectionable noise or vibration in any occupied areas of building, including providing additional brackets, bracing, etc., to prevent objectionable noise or vibration.

J. Operating and maintenance instructions: Immediately upon completion of work and before final inspection, turn over to owner one (1) set of shop drawings instruction sheets, bulletins, and pertinent information required by owner for proper operation and adjustment of each and every piece of equipment furnished. This information shall be bound in a hard-covered loose- leaf binder, typed and indexed into sections, and labeled for easy reference.

K. Manufacturer's names and model numbers: Are used to establish standard of quality. Use only such items or their approved equal. Architect’s approval required for all equipment.

L. As-built drawings: Submit, within thirty (30) days after date of acceptance, one (1) complete set of reproducible tracings marked to show the installed fire sprinkler system.

M. Guarantee: Refer to Division 1 Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping: Shall be any indicated under NFPA-13. If copper used, joints must be Silfos.

B. Building gate valves: Shall be approved outside screw and yoke with supervisory switch, Kennedy, Crane, or equal.
C. check valves: Shall be Straightway, Kennedy, Crane, or equal.
D. Electric alarm bell: Listed, weatherproof type.
E. Water flow switches: Autocall, or equal, WF-4 paddle type with contacts to sound local and remote alarm.
F. Piping: Shall be concealed in ceiling spaces except where the structure is exposed.
G. Hose threads: Shall conform to local Fire Prevention Bureau Standards.
H. Sprinkler heads:
   1. Sprinkler heads located in suspended ceilings shall be recessed mounted type and, where no ceiling occurs, shall be upright type.
   2. Sprinkler heads shall be located a minimum of 6” from lighting fixtures, ceiling diffusers, speakers, acoustic ceiling “T” bars, etc.
   3. Sprinkler heads in suspended ceilings shall have dull chrome finish and where no ceiling occurs, shall have a rough brass finish.
   4. Sprinkler heads shall be of temperature rating required for various area conditions. Heads at any location subject to mechanical injury shall have a wire screen guard.
   5. Furnish sprinkler head cabinet containing extra heads and a wrench as required by NFPA Pamphlet No. 13. Locate cabinet as directed by Architect.
I. Gauges: Shall be March, Trerice, or equal.
J. Escutcheons: Provide where pipes pierce finished walls and ceilings. Escutcheons shall be stamped steel, chrome plated, hinged, with set screw, Grinnell, Crane, or equal.
K. Hangers and bracing: Shall be per requirements in NFPA Pamphlet 13.
L. Identification signs: Shall be enameled metal of the standard design adopted by the Automatic Sprinkler Industry.
M. All pipes: Piercing roof members or exterior walls shall be flashed watertight.
N. Drain valves, inspector’s test valves, and control valves: Shall be fitted with enamel signs indicating their purpose and use.

PART 3 - EXECUTION

3.1 GENERAL

A. Criteria: The system shall be hydraulically designed, installed, and tested in conformance with NFPA 13, latest edition.
B. Coordination: Work must be completely coordinated with other crafts. Where conflicts occur, sprinkler piping must be relocated. Advise Architect of unavoidable conflicts prior to bidding.
C. Drawings and approval:
   1. The Contractor shall coordinate closely with the Architect on the routing of fire sprinkler pipe and the locations of fire sprinkler heads. The clearances on this project are limited, and the fire sprinkler system will be exposed in many areas. Progress drawings are to be submitted by the Contractor to the Architect showing proposed fire sprinkler pipe routing, pipe sizes and head locations. The Architect will provide comments and propose changes to the routing of piping, location of heads and any other changes necessary to meet the architectural requirements of the project. This process is to continue until the Architect approves the progress drawings.
   2. The Contractor shall provide scaled drawings showing the location of all sprinkler heads, piping, and hangers, installation of post indicating valve and fire department connection, including hydraulic calculations. These documents shall bear the approval of the local Fire Prevention Bureau, Insurance Service, if required, the State and/or local Fire Marshal, indicating adequacy of spacing of the heads and pipe sizes. Submit six (6) copies of approved documents to the Architect prior to commencement of work for

approval. The Architect reserves the right to make minor adjustments in sprinkler head locations (without added cost to the Owner) so long as additional heads are not required by the change.

3. Before receiving final approval of the job, furnish a written statement to the effect that the work has been completed and tested in accordance with the approved drawings and specifications.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions, Supplementary Conditions and Division 1 Requirements apply to the work specified in this Section.

1.2 SUMMARY

A. All materials and operations for a complete and operating plumbing system including, but not limited to, the following:
   1. Soil, waste, and vent piping systems inside the building to the connections to site piping 5'-0" outside the building.
   2. Rainwater leader and overflow drainage piping inside the building to the connections to site piping 5'-0" outside the building.
   3. Cold water, hot water and hot water return piping systems inside the building including cold water piping connections to existing piping and to site piping 5'-0" outside the building.
   4. Natural gas piping system inside the building to connections to existing piping.
   5. Condensate drain piping systems - mechanical equipment.
   6. Condensate drain piping system - condensing water heater.
   7. Water heater vent and inlet air piping.
   8. Plumbing fixtures and trim, including required backing.
   9. Connection to mechanical equipment.
   10. Trenching and backfilling required for plumbing systems.

1.3 RELATED SECTIONS

A. Heating, Ventilating & Air Conditioning Systems, Section 23 00 00.

B. Electrical, Division 26.

C. Earthwork, Division 31.

1.4 GENERAL REQUIREMENTS

A. Verification of Conditions
   1. Prior to installation of plumbing work, Contractor shall inspect all surfaces to receive said work and arrange with the general Contractor for the satisfactory correction of all defects in workmanship and/or material that could interfere with the work specified herein.
   2. Installation of any plumbing work or materials on any surface shall constitute acceptance by the Contractor of such surfaces as being in proper condition to receive herein specified materials.

B. Examination of site: Examine site prior to bidding. Compare it with drawings and specifications. Check conditions and take measurements, which may affect work. No

PART 1 - GENERAL

1.1 Work Included

A. Objective: It is the objective of this specification to provide for the avoidance of excessive noise or vibration in the building due to the operation of equipment, and/or due to interconnected piping, ductwork or conduit.

B. Description of Work: Furnish, install, assemble, set up, test (hereinafter "provide") the following systems and equipment in accordance with the Contract Documents.
   1. Isolation of mechanical equipment including but not limited to fans, package air conditioning units, refrigeration compressors, cooling towers, evaporative condensers and pumps, including bases.
   2. Isolation for ductwork and piping (including but not limited to domestic hot and cold water, waster, soil, vent and including all piping connected to vibration equipment).
   3. Seismic restraints for all vibration isolated and non-vibration isolated equipment, piping, ductwork and in-line devices.
   4. Supervision and inspection of installation of vibration isolation to equipment.
   5. Provision of all Motion Restraints required by applicable codes for noise and vibration control equipment/systems specified herein.
   6. Coordination of Airtight Installation requirements at Mechanical Rooms and/or Drywall Duct Enclosures.

1.2 Related Work in Other Sections:

A. Concrete, Division 03

B. Thermal and Moisture Protection, Division 07

C. Finishes, Division 09

D. Plumbing, Division 22

E. Heating, Ventilating, and Air-Conditioning, Division 23

F. Electrical, Division 26

1.3 Reference Standards:

A. Standards: Provide equipment in accordance with the latest edition and revisions of all applicable standards and specifications of all appropriate agencies including, but not limited to, the following:
   1. American Institute of Steel Construction (AISC) publications:
      a. Specification for the Design, Fabrication and Erection of Structural Steel Buildings (13th Edition).
   2. American National Standards Institute (ANSI) Standard
      a. B027.2-965 – Plan Washers.

allowance shall subsequently be made for any extra expense due to failure to make such examination.

C. Manufacturer's directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over drawings and specifications. Where these are in conflict with drawings and specifications, notify Architect for clarifications before installing the work.

D. Codes: Work and materials shall be in full accordance with all applicable local or state ordinances, California Building Code, California Plumbing Code, National Fire Protection Association, State of California Safety Orders, and State Fire Marshal. Whenever drawings and specifications require larger sizes or higher standards than are required by regulations, drawings and specifications govern. Whenever drawings or specifications require something, which will violate regulations, regulations govern. No extra charge will be paid for furnishing items required by regulations but not specified or shown on drawings.

E. Cooperation with other trades: Schedule work and cooperate with other divisions to avoid delays, interferences and unnecessary work, conforming to construction schedule, making installation when and where required. A special effort shall be made to coordinate with the mechanical Contractor so as not to block installation of the mechanical systems. The clearances above ceilings on this project are limited and the ductwork and piping are to have the highest priority. All plumbing work is to be coordinated with the mechanical Contractor such that the ductwork and piping can be installed in the locations shown on the mechanical drawings. If installed work is later found to interfere with work of other divisions, make all necessary changes at Contractor's expense.

F. Licenses, permits, services, and fees: Secure and pay for all licenses required to begin, perform, and complete work.

G. Quietness of operation: Adjust, repair, or replace any equipment producing objectionable noise or vibration in any occupied areas of building, including providing additional brackets, bracing, etc., to prevent objectionable noise or vibration.

H. All components of the cold water system are to be in full compliance with CA AB 1953.

1.5 SUBMITTALS

A. General:
1. Refer also to Division 01 for additional submittal requirements.
2. When specific names are used in connection with materials, they are used as standards only, but this implies no right to use other materials or methods unless approved by the Architect.
3. Decision of the Architect shall govern as to what materials are acceptable substitutions. Burden of proof as to equality of any proposed fixtures, material, or equipment shall be upon the Contractor. Petition in favor of proposed substitute materials shall be made directly by the Contractor. If any tests are necessary to determine quality of proposed items, such tests shall be made at

3. ASTM – American Society for Testing and Materials
   a. Specification A123/A123M-09 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. Test Method ASTM D471-10 Standard Test Method for Rubber Property-Effect of Liquids.
   c. Test Method ASTM D2240-05(2010) Standard Test Method for Rubber Property- Durometer Hardness.
   d. Test Method ASTM E84-11a Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. Specification A6/A6M-11 Standard Specification for General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling.
   f. Specification A36/A36M-08 Standard Specification for Carbon Structural Steel.
   g. Specification A53/A53M-10 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   h. Specification B663-94(2006) Standard Specification for Silver-Tungsten Carbide Electrical Contact Material.
   i. Specification A307-10 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   j. Specification A500/A500M-10a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   k. Specification A501-07 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   l. Specification A1011/A1011M-10 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
4. AWS – American Welding Society, Inc.
   a. AWS D1.1 – 2010 Structural Welding Code – Steel.
5. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers
   a. 2007 HVAC Applications Manual, Chapter 47.
6. SMACNA – Sheet Metal & Air Conditioning Contractor's National Association, Inc.
   a. Rectangular Industrial Duct Construction Standards, 2nd edition, 2004.
   b. Round Industrial Duct Construction Standards, 3rd edition, 1999.
   c. HVAC Duct Construction Standards - Metal & Flexible, 3rd edition, 2005.
   d. Architectural Sheet Metal Manual, 6th edition, 2003.
   e. Seismic Restraint Manual: Guidelines for Mechanical Systems, 2nd edition, 2008.

1.4 Quality Assurance

A. Codes: Perform installation in accordance with all applicable international, federal, state, county, municipal and local codes and regulations.

B. Conflicts: Present any conflicts between codes, regulations, specifications and/or requirements at least thirty (30) days prior to the commencement of the scheduled work.

C. Related Provisions: Division 01 – General Provisions, Division 22 – Plumbing: Apply to

the expense of the Contractor by an unbiased laboratory satisfactory to the Architect.

4. Submit shop drawings and material list in six (6) copies. Submit material list and shop drawings after official award of contract. Obtain approval of the Architect before installation. Shop drawings shall be submitted for all materials, equipment, and controls.
5. Check shop drawings and submittals before forwarding to Architect and ascertain that submittals meet all requirements of drawings and specifications and conform to structural space conditions.
6. Shop drawings also shall be prepared for modifications to architectural, plumbing, electrical, and mechanical work required by proposed materials - i.e., relocation of drains, revised electrical circuits, relocation of penetrations, etc.
7. Installation of any approved substituted equipment is the Contractor's responsibility and any changes required to work included under other sections for installation of approved substituted equipment must be made to the satisfaction of the Architect and without any additional cost. Approval by Architect of substituted equipment and/or dimension drawings does not waive these requirements.
8. Review of drawings and materials submitted for approval shall not be construed as a complete check or constitute a waiver of the requirements of the drawings and specifications. This review shall not relieve the Contractor of the responsibility to fit the proposed materials to the spaces provided and to effect necessary rearrangement or construction of other work. Contractor agrees that shop drawing submittals processed by the Architect do not become contract documents and are not change orders; that the purpose of the shop drawing review is to establish a reporting procedure and is intended for the Contractor's convenience in organizing his work and to permit the Architect to monitor the Contractor's progress and understanding of the design. If deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents are discovered either prior to or after the shop drawing submittals are processed by the Architect, the Contractor agrees that the contract documents shall control and shall be followed.
9. Submittal lists shall include the identifying marks assigned to the items. Give name of manufacturer, brand name, and catalog number of each item. Submit complete list at one time with items arranged and identified in numerical sequence within each section and article specifications. Listing items "as specified" without both make and model or type designation is not acceptable, except as noted. Only pipe and fittings not specified by brand names may be listed "as specified" without manufacturer's name, provided proposed materials comply with specification requirements.
10. Descriptive Data: Submit six (6) copies of complete description information and performance data covering equipment that is specified but for which catalog plate numbers, brand names, or specific models have not been used.
11. Submittal of substitutions shall be limited to one proposal for each type or kind of item, unless otherwise permitted by the Architect.

the work of this Section.

D. Product Suppliers: All vibration isolation devices, equipment bases and frames for equipment and piping furnished under Division 22 shall be designed and furnished by no more than two different isolator manufacturers and no single vibrating element shall be isolated by the products of more than one isolator manufacturer.

E. Supervision: The installation of all vibration isolation units, and associated hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative.

1.5 Coordination

A. Coordinate with Finish Systems, Piping Systems and Equipment, Water Cooling and Heating, Plumbing Systems, Heating, Ventilating and Air Conditioning sections for installation of vibration isolation. Coordinate with Concrete trade for equipment inertia bases. Coordinate Work of this Section with all other impacted trades.

1.6 Submittals

A. Refer to Division 01 for procedures.

B. Descriptive Data - Submit the following:
   1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications and schedules herein. Include load versus deflection curves.
   2. An itemized list showing the items of equipment, piping, etc., to be isolated, the isolator type and model number selected, isolator loading and deflection, wire diameter and number of coils in springs, and references to specific shop drawings showing frame construction where specified.
   3. Written approval of the frame design to be used, obtained from the equipment manufacturer.
   4. Written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices, including hangers and bases; alternatively the equipment may be installed by the vibration isolation manufacturer.
   5. For each Motion Restraint to be provided on this project which is neither already fully detailed in the plan nor an OSHPD pre-approved spring/frame support, the contractor shall submit a stress analysis prepared by California licensed Civil or Structural Engineer.
      a. Provide sufficient detail to permit architect and authorities having jurisdiction to verify compliance with all applicable Codes and these specifications.
      b. For vibration isolation used with base mounted equipment over 300 pounds or suspended equipment over 20 pounds, provide calculations for:
         i Shear,
         ii Pull-up,
         iii primary overturning and
         iv secondary overturning.

1.6 DRAWINGS, SPECIFICATIONS, AND COORDINATION OF WORK

A. Drawings are essentially diagrammatic. Size and locations of equipment are generally shown to scale. Make use of data in all contract documents, and verify this information against field conditions.

B. The drawings indicate the required size and point of termination of ductwork, pipes, and equipment. Install pipe with all necessary offsets and fittings to conform to the structure, avoid obstructions, preserve headroom, maintain required accessibility, and satisfy the requirements of the governing codes and the standards of good practice.

C. The architectural and structural drawings and specifications take precedence over the mechanical drawings in the representation of the general construction work. Refer to the drawings, specifications, and review shop drawings for all work in order to coordinate plumbing work with the other work of the project.

D. Where changes in indicated locations or arrangements are necessary due to conditions in building construction, interference with work in other divisions, or conflict in location, make changes at no cost to the Owner deviations, offsets, rises or drops in piping that may be necessary, whether shown or not, shall be made at no expense to Owner.

E. Bring discrepancies between different drawings, between drawings and actual field conditions, or between drawings and specifications promptly to the attention of the Architect for decision, and stop all work on affected areas subject to resolution of the conflict.

1.7 MATERIALS AND WORKMANSHIP

A. All materials and equipment to be new and in perfect condition. Materials or equipment for similar uses are to be of same type and manufacturer.

B. Workmanship shall be of best standard practice of the trade.

1.8 PROTECTION OF EQUIPMENT

A. The Contractor shall be responsible for damage to any of the work of this section until final acceptance. Cover all openings, apparatus, equipment, and appliances both before and after being set in place to prevent misuse or disfigurement of the apparatus, equipment, or appliances.

1.9 OPENINGS

A. The Contractor shall cooperate with other trades in providing information for openings required in walls, floors, and roof for pipe and equipment.

B. The Contractor shall pay all extra costs for cutting of openings as a result of incorrect, delayed, or neglected information.

C. Make absolutely watertight any openings through waterproofed construction caused by the penetration of piping and in a manner approved by the Architect.

c. For isolator and frame systems that have a current OSHPD approval for installation under identical conditions to those on this project. The contractor may submit OSHPD pre-approved detail in lieu of a project specific calculation requiring under the proceeding paragraphs.

6. An itemized list of all items of equipment to be fitted with flexible piping and/or duct connections.
   a. Flexible piping and/or duct submittals shall contain all information and calculations to demonstrate conformance and suitability for the equipment operating conditions including but not limited to pressure, temperature, capacity, mounting, maintenance, etc.
   b. Submittals shall also include independent acoustical test data demonstrating at least 20 dB attenuation of vibration accelerations at typical blade passage frequencies.
7. A schedule of airtight and resilient sleeves which will be used where ducts, pipes and/or conduit penetrate building construction, including where necessary in order to maintain airtight mechanical rooms.

C. Shop Drawings - Submit the following and secure approvals prior to fabrication:
1. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.
2. Drawings showing methods for suspensions, support, guides, etc., for piping and ductwork, etc.
3. Drawings showing methods, for isolation of ducts, pipes, etc., piercing walls, slabs, beams, etc.
4. Drawing showing methods numbers and details of Motion Restraints and anchors for equipment, frames, isolators, piping, ductwork, etc., including calculations as above.
   a. Where Contractor-proposed substitutions change the weight, size, configuration or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, the Contractor shall submit calculations for proposed anchors and supports, and install them as shown in these calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
   b. Where Contractor-proposed substitutions are claimed to have no effect on anchors and supports detailed on the Contractor Documents, Contractor shall submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
   c. Contractor shall submit details and calculations for all embedded inserts, drilled inserts and other fasteners for attachments of suspended components showing the load-carrying capacity of each device calculated in accordance with Chapter 16 of the California Building Code. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
   d. For all anchorages and supports not detailed on the Contract Documents, Contractor shall submit details and calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
5. Details for concrete and steel bases including anchor bolt locations.
6. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, showing compliance with California Building Code and

1.10 CLEAN-UP

A. Thoroughly clean all parts of the apparatus and equipment. Exposed parts which are to be painted shall be thoroughly cleaned and all grease and oil spots removed with cleaning solvent.

B. Remove all debris and surplus equipment and leave installation in perfect condition ready for use.

1.11 CONSTRUCTION REVIEW

A. All services rendered by the Architect or any of his consultants consist of professional opinions and recommendations made in accordance with generally accepted engineering practice.

B. Under no circumstances is it the intent of the Architect or any of his consultants to directly control the physical activities of the Contractor or the Contractor's workmen in the accomplishment of work on this project.

C. The presence of the field representative of the Architect or any of his consultants at the site is to provide to the Owner and/or Architect an additional source of professional advice, opinions, and recommendations based upon the field representative's observations.

1.12 SAFETY

A. In accordance with generally accepted construction practices, the Contractor will be solely and completely responsible for conditions on the jobsite, including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal working hours.

B. Construction review by the Architect or any of his consultants is not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction take out extra space site or at any other location.

1.13 OPERATING INSTRUCTIONS

A. Comply with the requirements of Division 1 – General Requirements.

B. Upon completion of work, the Contractor shall place a competent person in charge who will operate the system and instruct the Owner's representative in all details of the operation and maintenance of the plumbing system.

C. The Contractor shall carefully prepare four (4) descriptive booklets of the entire plumbing systems and a full description of the operation and maintenance of each piece of equipment.

D. Operating instructions manuals are to include names, addresses, and telephone numbers for the following: project name, Owner, General Contractor, Plumbing Subcontractor, and equipment manufacturer’s (including local representatives).

coordination with the Project Architectural, Structural and Mechanical Documents.

7. Details of flexible piping and duct connections for all typical conditions listed in the schedule provided above.

PART 2 - PRODUCTS

2.1 General Properties

A. Deflection: Vibration isolators shall have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

B. Range: Isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range 60% above the design deflection.

C. Ratio: Ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 1.3.

D. Nested: Unless specifically noted, nested spring designs shall not be permitted.

E. Uniformity: Vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than 10%.

F. Isolation: Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems within 10% up to 50 dB or greater at all frequencies above 150 Hz.

G. Protection: Isolators installed outdoors shall be designed for such exposure suitable to the Project conditions.
   1. Springs shall be coated in neoprene or PVC, or shall be hot dip galvanized.
   2. All neoprene mountings shall have a Shore-A hardness of 30 to 50, after minimum aging of 20 days or corresponding oven-aging.

2.2 Isolator Description

A. Application Cross-Reference: For application and the specific static deflection requirements of the isolators described below, refer to schedules and references elsewhere herein.
   1. Type MS & MSSR: Bare spring type equipped with leveling bolts and with two layers of ribbed or waffled neoprene pad separated by a 1/16" galvanized steel plate under the base plate. Type MSSR shall be fabricated with integral steel housing, with inspection ports, providing all directional motion restraint.
   2. Type MSL: Bare spring type with two layers of ribbed neoprene pad with 1/16" galvanized steel separator between layers under the base plate. Provide limit stops to prohibit spring extension if the load is removed. These stops shall serve as rigid blocking during erections so that the installed and operating heights shall

1.14 GUARANTEE

A. The Contractor shall furnish a written guarantee to the Owner that the new materials, equipment, and installation are new, free from mechanical defects, noiseless, and are in perfect operating condition.

B. He shall guarantee to replace and repair at his own expense any and all unsatisfactory and defective work and items to the satisfaction of the Owner for a period of one (1) year after the system is put to beneficial use.

C. The Contractor shall also furnish the Owner with all manufacturer's written guarantees of materials and equipment.

D. Refer also to Division 1 requirements

1.15 RECORD DRAWINGS

A. Refer to Division 01 – General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil, Waste and Vent Piping:
   1. Above Grade: No-Hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe, or Tyler Pipe. Joints shall be made with No-Hub couplings with neoprene gasket, stainless shield and clamp, Tyler pipe, or equal. No-Hub couplings shall conform to CISPI Standard 310 and ASTM A 1277. Pipe, fittings and joints shall be manufactured in the U.S.A.
   2. Below Grade: No-Hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe or Tyler Pipe. Joints shall be made with heavy duty No-Hub couplings, Husky SD4000, Clamp All 125 or MG Coupling. No-Hub couplings shall conform to CISPI Standard 310 and ASTM A 1277. Pipe, fittings and joints shall be manufactured in the U.S.A.

B. Rainwater Leader And Overflow Drainage Piping:
   1. Above Grade: No-hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe, Tyler Pipe or equal. Joints shall be made with No-hub couplings with neoprene gasket, stainless shield and clamp, Tyler pipe, or equal.

be the same. Provide a minimum of 1/2" clearance around restraining bolts and between the limit stops and the housing so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation.

3. Type HS: Suspension hangers having a steel frame and spring element in series with a 1” thick neoprene pad with integral grommet. The design static deflection under load shall be as shown on the schedule. The isolator shall be designed so hanger rod may be misaligned 15 degrees relative to the vertical without touching integral grommet inset in hanger box frame.
4. Type HD: Spring hangers, load transfer. Same as Type HS with washer and nut assembly and indicator for load transfer and deflection readout.
5. Type HN: Suspension hangers having a neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5" designed to preclude contact of hanger rods with frame at up to 15 degrees misalignment.
6. Type MN: Neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5".
7. Type NSP: Neoprene pad. Waffled or ribbed. Typically 5/16” to 1/2" thickness. Durometer of 50 maximum. Static deflection typically 0.05". Nominal design 40 durometer for 0.05" static deflection under 60 psi load. Provide steel load distribution plates. Size of pad to be selected by isolator supplier based on load per point.
8. Type MND: Neoprene Mount, Deep Displacement. A machinery mount with a neoprene diagonal lattice structure located between steel base and a support plates. Suitable for loads from 300 to 4000 lbs and for driving frequencies as low as 6 Hz. Capable of providing static deflections from 5/8" to 1" with lateral stability.

2.3 Equipment Frames

A. General Properties: Mounting frames and/or brackets shall be provided to carry the load of the equipment without stressing or causing mechanical distortion of the equipment. Each piece of equipment shall be supported at least four points by vibration isolators and restrained at least four locations by Motion Restraint.
   1. Rigid Steel (RS): Construction:
      a. Rectangular with a minimum of four pieces of welded, wide flange structural steel with welded height saving brackets to accept the isolators. Additional frame members shall be provided as necessary to support pumps, motors, etc.
      b. The section depth of the frame members shall be greater than 1/10 of the length of the longest frame member, and shall be constant in all four perimeter frame pieces.
   2. Concrete Inertia Bases (CI): Construction:
      a. Welded structural forms with 1/2" (minimum) steel reinforcing bars welded in place on at least 6" centers running in both directions. The bottom edge of the steel bars shall be 1-1/2" from the bottom of the base. Drilled steel members with sleeves welded below the holes to receive anchor bolts.
      b. Provide height saving brackets at all mounting locations.
      c. Except where otherwise noted, the base weight shall be at least equal to the weight of the mounted equipment. Concrete shall be not less than 3" in thickness. Provide a minimum clearance of 2" between the concrete

2. Below Grade: No-hub cast iron soil pipe and fittings. All pipe and fittings shall conform to CISPI 301, ASTM 888 or ASTM A-74 standards. Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings are to be manufactured by AB&I Foundry, Charlotte Pipe, Tyler Pipe or equal. Joints shall be made with heavy duty No-hub couplings with neoprene gasket, stainless shield and clamps. Couplings shall be constructed of type 304 stainless steel with 305 stainless steel worm drive screws. Gaskets per ASTM C564. (4 band 80 inch pound torque). Mission Heavy Weight, Husky SD4000, or equal.

C. Cold Water, Hot Water and Hot Water Return Piping:
1. Above and Below Grade: Type L copper tubing ANSI H23.1 with wrought copper sweat fittings ANSI B16.22 joined with lead free solder. Wrap below grade piping per AWWA HOC 203.

D. Natural Gas Piping:
1. Above grade: Schedule 40 black steel pipe ANSI B125.2 and 150 PSI black malleable iron screwed fittings ANSI B16.3 for piping 2” and smaller and seamless welded joint 2-1/2” and larger. Pipe and fittings outside of the buildings are to be galvanized. Wrap below grade piping per AWWA HOC 203.

E. Condensate Drain Piping - Mechanical Equipment:
1. Type M copper tubing ANSI H23.1 with wrought copper sweat fittings ANSI B16.22 joined with lead free solder.

F. Condensate Drainage Piping - Condensing Water Heater:
1. Condensate piping from condensing boilers is to be Schedule 40 PVC pipe and fittings with solvent weld joints.
2. Install condensate neutralizer in condensate drainage piping. Follow the neutralizer manufacturer's installation instructions.

G. Water Heater Vent and Inlet Air Piping:
1. Vent and inlet air piping for the condensing water heater shall be schedule 40 PVC pipe and fittings with solvent weld joints.

H. Unions and Flanges:
1. Steel pipe unions: Malleable iron ground joint pattern with brass to iron seats, 150 psi.
2. Steel pipe flanges: ANSI B16.C, 150 psi forged steel welding type with flat face.
3. Copper tubing unions: 150 psi ground joint cast bronze unions with sweat connections.
4. Copper tubing flanges: ANSI B16.24, bronze, 150 psi to match standard ASA 150 psi steel flanges with flat face.
5. Flange gaskets: Crane Co Cranite, 1/16" full face sheet packing, 150 psi. Coat gaskets with thread lubricant before installation.

I. Dielectric Protection:

base and the floor slab or housekeeping pad.

3. Type BR: Brackets to equipment. Height saving brackets attached directly to equipment where rigidity of same does not require supplemental frame.
4. Type TS: Trapeze. Used to distribute load or to conserve space. Supporting sling of steel members with mount or hangers at each end. The Section depth of the frame members shall be greater than 1/10 the depth of the longest frame member.
5. Type RPA: Rail Pair Assembly Construction:
   a. Paired mounting rails along the longest base dimension of the equipment to be isolated.
   b. Provide isolation by bare springs mounted on 1/4" thick neoprene cups at the bottom and under a threaded metal cap at the top. A height adjustment bolt shall attach the metal cap to the upper angle iron rail. The size and spacing of the springs shall be selected by the vibration isolation manufacturer so as to accommodate the equipment's center of gravity and provide a level installation.
      i Vertical height restraint bolts, similar to those provided with Type MSL spring mounts, are not acceptable in lieu of independent Motion Restraint specified below.
      ii Refer to Part 3 for special execution instructions for RPA.
6. Integrated Roof-mounted Spring and Frame (IRSF): The integrated roof-mounted spring and frame assembly shall consist of a rectangular angle iron equipment frame supported by a type MS isolator on a steel channel roof perimeter. This assembly integrates with the roof insulation and canting to provide a weather-tight seal with cover plates removable for isolator inspection. The IRSF shall provide integral motion restraint and shall be available in stock modular construction components.

2.4 Equivalent Vibration Isolation and Equipment Frames

A. Isolators
   1. Acceptable subject to 2.2 above:

Type	Description	Mason Industries	Vibrex/ Saussé	Lord Mechanical Products	Kinetics	Amber Booth	Vibration, Mounting & Controls
MS	Spring Mount	SLF*	RMSG*	--	FDS*	SW*	ADC*
MSSR	Spring Mount - Housed	SSLFH	RMSP-EQ	--	--	--	AEQ
MSL	Spring Mount with Limit Stop	SLR C series	RMLS-EQ	--	FLS	CT	AWR
	Under 1.5" S.D. and under 200 pounds load per isol.	SLR A series	RMUJ-EQ-SH	--	FLS	CT	AWR

1. Location: For connection between dissimilar metals in the piping systems to control corrosion caused by galvanic or electrolytic action. No dielectric unions allowed.
2. Listing: Victaulic Style 47, Lochinvar V-line, Waterway or equal.
   a. Dielectric couplings: Threaded for sizes 2 inches and smaller, grooved or flanged for 2-1/2 inches and larger.

J. Thread Lubricant For Steel Pipe: Armite Joint Seal Compound No. 250.

K. Valves: Shall be a product of single manufacturer, Red-White, NIBCO, Milwaukee or equal.
1. Gate valves (threaded): #280, bronze, 125 psi.
2. Gate valves (solder): #281, bronze, 125 psi.
3. Ball valves (threaded): #5092, bronze, 400 psi.
4. Ball valves (solder): #5095, bronze, 400 psi.
5. Ball valves (natural gas): #5044F, Brass Body, 600 psi, full port.
6. Valves shall be same size as line in which they are installed. No valve shall be installed with stem pointed below horizontal.

L. Pipe Sleeves: Adjus-To-Crete 24 ga., electrogalvanized sheet metal adjustable sleeve, or equal.

M. Pipe Hangers and Supports: Superstrut or equal.
1. Plumbing Piping – Soil, Waste, and Vent:
   a. Conform to ASME B31.9.
   b. Hangers for Pipe Sizes ½ inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   c. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   d. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   e. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
2. Plumbing Piping – Water:
   a. Conform to ASME B31.9
   b. Hangers for Pipe Sizes ½ inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   c. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   d. Hangers for Hot Pipe Sizes 2 Inches to 4 inches and Over: Carbon steel, adjustable, clevis.
   e. Multiple or Trapeze hangers: Steel channels with welded supports and hanger rods.
   f. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

N. Seismic Bracing: Conform to SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems, Second Edition, 1998.

*Unrestrained isolation systems require separate Motion Restraint as specified below.

B. Frames and Curbs
1. Acceptable subject to 2.3 above:

Type	Description	Mason Industries	Vibrex/ Saussé	Kinetics	Amber Booth	Vibration Mountings & Controls
RS	Rigid Steel	MSL/WFSL	RMSB	SFB	--	WFB-AC
CI	Concrete Inertia Base	KSL	RMSB-I	CIB	--	WPF-AC
RPA	Spring Rail w/ Independent Snubber	ASSR*	RMR-3200	--	--	--
IRSF	Integrated Roof/Spring Mount	ISC or RSC	VIC-EQ or VibroCURBII	ESR	--	--

2.5 Motion Restraints

A. Objective: Provide motion restraining devices at all vibration isolated piping and equipment. Design restraints to comply with applicable Code in Project Jurisdiction.

B. General properties:
1. Restraints shall permit adjustment during installation to insure sufficient clearance between vibration isolated element and rigid restraining device.
2. Restraints at base supported equipment shall include resilient neoprene pads at all potential contact areas between isolated equipment and rigid restraining element.
3. Restraints shall be selected to be capable of providing the after installation adjustment and clearance tolerances required under Part 3 of this Section.

C. Restraint Description
1. Restraining devices at base supported vibration isolated equipment shall be as manufactured by Mason Industries, type Z-1011 or equal by Vibrex/Saussé, Amber Booth or Kinetics.
2. Coordinate restraint bolt locations with the structural and mechanical drawings and conditions.
3. Restraints at suspended piping and equipment shall consist of stainless steel cables together with neoprene snubbers arranged to achieve the required all-directional restraint and sized to resist the forces defined. Shop Drawings shall indicate proposed method for achieving vertical restraint for ceiling suspended piping. Cables shall have sufficient slack to avoid short circuiting the vibration isolators.

2.6 Piping Resilient Support and Suspension

A. Execution Cross-Reference: Refer elsewhere in this Section for the requirements of Resilient Penetrations and Flexible Connections. Refer to Part 3 for the extent of the

O. Cleanouts:
   1. Zurn, Josam, J.K. Smith or equal, as scheduled on drawings. Cleanouts shall be furnished with flashing collars when installed in membraned slabs. Furnish suitable wrought iron or steel wrenches for each style of cleanout plug cap.
   2. Cleanouts at Interior Finished Floor Areas:
      a. Lacquered cast iron with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
   3. Cleanouts at Interior Finished Wall Areas:
      a. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
   4. Cleanouts at Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

P. Drains: Zurn, Josam, J.R. Smith or equal, as scheduled on drawings. Drains shall be furnished with flashing collars when installed in membraned slabs. Furnish floor drains with trap primer connections. ASME A1123.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

Q. Insulation:
   1. Hot Water and Hot Water Return Piping:
      a. Owens/Corning Fiberglass ASJ/SSL-II, or equal, heavy density, 2-piece sectional pipe insulation, jacketed with vapor barrier laminate, continuous pressure sealing adhesive lap and butt joint stripe, 1-1/2” thick.
      b. Apply insulation over clean, dry surfaces butting adjoining sections firmly together, seal smoothly and securely with self-sealing longitudinal lap. Adhere factory furnished 3” wide pressure sealing strips to joints.
      c. Insulate fittings with fiberglass strips and finish with one-piece PVC fitting cover (Zeston).

R. Piping Identification:
   1. Piping identification shall be manufactured by Marking Services, Incorporated or equal.
   2. Materials:
      a. Color: Unless specified otherwise, conform with ANSI/ASNE A13.1.
      b. Plastic nameplates: Laminated 3-layer plastic with engraved black 2 inch high letters on light contrasting background color.
      c. Metal tags: brass aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
      d. Plastic pipe markers: Factory fabricated, flexible, semi-rigid, preformed to fit around pipe or pipe covering, minimum information indicating flow direction arrow and fluid being conveyed.

S. Plumbing Fixtures: Make and model as scheduled on the drawings or equal.
   1. Fixtures and trim: As described in manufacturer's catalog with modifications noted.
   2. Vitreous ware fixtures: White, twice-fired, vitreous china.

resilient piping support cited below.

1. At horizontal suspended pipe 2" and smaller connected to vibrating equipment over 1/2 HP provide Type HS isolator or floor supported Type MSL isolator with a minimum 1.0” static deflection. At horizontal suspended piping larger than 2" provide type HD isolator or floor supported Type MSL isolator with a minimum of 1-1/2" static deflection.
2. At vertical riser pipe supports supporting piping attached to vibrating equipment over 1/2 hp over 1.0" O.D., provide Type MS isolators selected for a minimum static deflection of 1.0".
3. At pipe anchors for piping attached to vibrating equipment provide Types MN or HN to avoid direct contact of piping with building.
4. Pipe sway braces where required and attached to vibrating equipment shall utilize neoprene elements of 40 durometer maximum and of 3/8" minimum thickness, Type MN shall be used where such braces are required to accommodate both tension and compression forces.

B. Domestic Water: At horizontal Domestic water piping provide wool felt isolator backed with metal similar to Stoneman Trisolator at each pipe hanger rigging or clamp specified under Division 22. At vertical runs provide Type MN mounts attached to pipe clamps specified under Division 22.

2.7 Flexible Piping Connections

A. Application: Provide flexible piping connections between piping and vibrating equipment including but not limited to: pumps, cooling towers, air handling units coils and compressors.

B. Elastomeric Multi-sphere Connectors:
   1. Construction:
      a. Provide flexible piping connections to units listed above and similar at all connection points via flexible neoprene connectors consisting of multiple plys of nylon tire cord fabric and neoprene. Neoprene elements shall form at minimum a dual sphere muffler construction at each connection. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" in diameter or larger shall be manufactured with floating metal flanges recessed to lock the connector's raised face neoprene flanges.
      b. Connectors shall be rated a minimum of 150 psi at 220°F. Flanged equipment shall be directly connected to neoprene elbows in the size range of 2-1/2" to 12" diameter if the piping makes a 90 degrees turn at the equipment. All straight through connections shall be made via twin sphere configuration per A above.

C. Acceptable subject to above:
   1. Safeflex SFDEJ by Mason Industries, Inc.
   2. C. Flex by MG Piping Products Company
   3. Style 2600 by Amber/Booth Company
   4. Merflex Style 5500 TS by Mercer Rubber Company
   5. Type VMT by Vibration Mounting & Controls
   6. or equal.

3. Fixture trim and exposed metal items: Chrome plated unless otherwise noted. Pipes passing through finished walls shall have chrome plated escutcheon plates.
4. Install stops in each water supply to fixtures.
5. No unoccupied fixture faucet holes shall be permitted.
6. Fit exposed fixture setting bolts with china caps.
7. Properly support and securely fasten all fixtures to adequate backing per manufacturer's recommendations.
8. Point up joints between fixtures and wall or floors with white mastic. Mastic shall have sufficient resiliency to prevent cracking or pulling away from wall due to fixture movement.
9. Rough-in and set fixtures to height shown on Architectural drawings or as standard for the industry.
10. Plumbing faucets and all other components in the cold water and hot water systems are to be in full compliance with CA AB 1953.

T. Escutcheon Plates: For pipes passing through finished ceilings, walls, and floors in conspicuous locations, use chromium-plated steel floor and ceiling plates with set screw or other approved means of holding securely in place.

U. Flashing and Counterflashing: For cast iron pipe penetrations through roof, use 4 pound lead flashing with counterflashing. For copper pipe penetrations through roof, use copper flashing and counterflashing.

V. Access Panels:
1. In areas other than toilet rooms: Karp Model DSC-214-M, or equal prime coated steel with 14 gauge door and trim and 16 gauge frame, continuous concealed piano hinge, flush screwdriver operated cam latch, size shall be 12"x12".
2. In toilet rooms: Karp Model DSC-214-M, or equal, Type 304 stainless steel, continuous concealed piano hinge, flush screwdriver operated cam latch, size shall be 12"x12".

W. Underground, Uninsulated, Steel Pipe Lines: Shall be wrapped conforming to AWWA HOC203.

X. Equipment Scheduled on Drawings – Make and model as scheduled on the drawings or equal:
1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Shower.
6. Mop sinks.
7. Hose bibbs.
8. Wall boxes.
9. Floor drains.
10. Floor cleanouts.
11. Grade cleanouts.
12. Wall cleanouts.

D. Metallic hoses:
   1. Where application requires higher temperature, pressure or unsuitable fluids, provide metallic hose in lieu of elastomeric connectors. Provide two each at every location where A applies above.
   2. Provide flexible connectors fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Stainless steel grades shall be 304, 316, or 321 as required for the application. Live lengths shall be as indicated, but not less than that recommended by the manufacturer for continuous vibration application.
   3. Provide in length as required by Part 3 of this Section.
   4. Acceptable:
      a. Type BBS, SS or BBF by Mason Industries, Inc.
      b. Type BBS, SS or BBF by Mercer Rubber Company
      c. Metal-Flex by Amber/Booth Company
      d. Stainless steel flexible connectors by DME, Inc.
      e. Type MFP by Vibration Mountings & Controls, Inc.
      f. or equal.

2.8 Resilient Penetrations

A. For piping or ductwork, (Field Fabricated Method):
   1. Sleeves: Sleeves of appropriate gage galvanized sheet metal shall be formed to at least the thickness of the penetrated construction and 3/4" to 1" larger in each cross-sectional dimension than the penetrating element.
      a. Acceptable:
         i Century-Line Sleeves by Thunderline Corporation
         ii Custom by Contractor
         iii or equal.
   2. Batt: Glass fiber of batt or mineral wool, 1 to 3 lb./cu. ft. density.
      a. Acceptable Manufacturers:
         i Certain-Teed
         ii Johns-Manville
         iii Owens-Corning
         iv or equal.
   3. Acoustical Sealant:
      a. Acceptable Manufacturers:
         i DAP
         ii Pecora
         iii Tremco
         iv U.S. Gypsum
         v 3M
         vi or equal.
   4. Firestop Sealant:
      a. Where required, resilient firestop caulking may be used in lieu of Acoustical Sealant when installed in strict conformance with the manufacturer's directions. Fully hardened firestop caulk shall develop a Shore A hardness of no greater than 35.
         i Acceptable, subject to approval for intended application by

13. Cleanouts,.
14. Water hammer arrestors.
15. Trap primer.
16. Water heaters.
17. Hot water recirculation pump.
18. Roof drains.
19. Overflow drains.

PART 3 - EXECUTION

3.1 GENERAL

A. Support exposed and concealed piping on specified hangers properly spaced and set to allow piping to adjust for temperature change expansion and contraction. Evenly space and support piping in parallel.

B. Coordinate with other trades to provide continuous support channel for all pipes and conduit in exposed locations.

C. Conceal piping in ceilings, furred walls, partitions and pipe spaces, except where noted otherwise. Provide maximum head room and run piping to maintain proper clearance for piping runs beforehand and with other divisions to insure clearance. Where work of other divisions prevents installation of piping shown on drawings, reroute piping as directed by Architect at no extra cost to Owner.

D. Install exposed piping parallel to or at right angles with building walls.

E. No valve, piece of equipment, or trim shall support the weight of any pipe. Install valves, traps, cleanouts, etc., in accessible locations.

F. Install piping free from traps and air pockets.

G. Use special wrenches in assembly of polished, chrome plated tubing and fittings so that no tool marks are left on pipe or fittings.

H. Wherever changes in sizes of piping occur, use reducing fittings.

I. Install unions adjacent to threaded valves, equipment, and at other points where required for disassembly.

J. Provide sleeves wherever pipes run through walls, slabs, beams, footings, and floors large enough for passage of pipe and/or pipe insulation. Sufficiently size sleeves to allow for contraction and expansion of pipe. Pack sleeves with approved packing material. Pack sleeves in walls and slabs below grade and through exterior walls above grade with waterproof mastic or grout.

K. Set floor cleanouts so top of plate and rim will be flush with top of finish flooring.

L. Where sleeves are missed or misplaced during canning, core holes with rotary diamond tooth core drills.

Authorities Having Jurisdiction:
1. G.E. Pensil 100 Firestop Sealant
2. Tremco Fyre-Sil Silicone Fire-stop Construction Sealant
3. 3M Fire Barrier Sealant
4. or equal.

B. For piping penetrations (Factory Fabricated Component Method):
1. A factory-fabricated sleeve assembly with outer sleeve of sheet metal and inner resilient liner of moisture-and vermin-resisting felt neoprene, glass fiber or foam rubber 1/2” to 3/4" thick and bonded to the sheet metal sleeve. Sleeve inside diameter shall be equal to outside diameter of penetrating element. Sleeve length shall be at least equal to the thickness of the penetrated construction. Sleeve shall be set and caulked airtight in penetrated construction and clamped tightly around penetrating element.
2. Acceptable:
   a. Mason Type SWS
   b. Peabody Type PS-1-D
   c. Potter-Roemer PR-Isolator
   d. Stoneman Engineering Trisolator
   e. B-Line B3195 Series
   f. or equal.
3. Where required, a fire rated factory fabricated sleeve and inner resilient liner of solid rubber links may be substituted for the preceding when installed in strict accordance with the manufacturer's instructions.
   a. Acceptable, subject to by Authorities Having Jurisdiction:
      i Link Seal by ThunderLine Corp.
      ii or equal.

2.9 Supporting Devices

A. General
1. Supports to be sized to suit load and selected to match mounting conditions.

B. Manufacturers
1. Equal products by the following manufacturers will be considered providing that

M. Fit exposed pipes, which pass through walls, ceilings, or floors in finished rooms and conspicuous locations with escutcheon plates.

N. Install insulating unions or flanges at ferrous and nonferrous piping connections.

O. Install 12” long air chamber on hot and cold water supplies to all fixtures and hose bibbs not protected by water hammer arrestors.

P. Install water hammer arrestors at all locations of fast closing positive shut-off valves and equipment with fast closing solenoid valves; including but not limited to flush valves, single handle faucets, dishwashers, etc. Install behind wall access panel with ball shut-off valve. Follow manufacturer’s installation instructions for proximity to valve and specific configuration of inlet piping.

Q. Install trap primers in complete accordance with the manufacturer’s recommendations.

R. Minimum bury for exterior piping: 30" below finish grade, except as otherwise noted or determined by invert elevations. Comply with NFPA 24 Section 104.4 and with CBC Section 1806.11 Pipes and Trenches.

3.2 PIPE HANGERS, SUPPORTS, AND BRACES

A. General: Support piping from building structure so that there is no apparent deflection in piping runs. Fit piping with steel sway braces and anchors to prevent vibration and/or horizontal displacement under load when required. Support piping only by approved pipe hangers. Pipes shall not be supported from, or braced to, ducts, other pipes, conduits, or any materials except building structure. Piping or equipment shall not be supported or hung by wire, rope, plumbers tape, or blocking of any kind.

B. Hanger spacing (not for piping or multiple piping supports):

Type of Pipe	1-1/2" diam. & smaller	2" diam. & lgr
Steel pipe	8'- 0"	10'- 0"
Copper tubing	6'- 0"	8'- 0"
Cast iron pipe	All sizes 5'- 0" max. and not less than one hanger per joint	

C. Multiple piping supports: 6'- 0".

D. Support vertical piping at each floor level with rise clamps.

E. Piping at completion of job shall be rigid and immobile. Install additional pipe supports, brackets, and hangers as required to accomplish a rigid and immobile piping system.

F. Double wrap copper pipe with heavy vinyl tape where pipe comes in contact with ferrous materials.

3.3 EXCAVATING, TRENCHING, AND BACKFILLING

A. Trenches: Shall have uniform grades. In case of over excavation, fill to bottom of pipe with selected fill or sand. Provide dewatering pumping as required.

all features of the specified product are provided:

a. Concrete fasteners:
   - i Phillips "Red-Head"
   - ii Remington
   - iii Ramset
   - iv Hilti
   - v Simpson Strong-Tie
   - vi or equal.

b. Concrete inserts and construction channel:
   - i Unistrut Corp.
   - ii GS Metals "Globe Strut"
   - iii Thomas & Betts "Kindorf" Corp.
   - iv or equal.

c. Conduit straps:
   - i O-Z/Gedney
   - ii Erico "Caddy" Fastening Products
   - iii Thomas & Betts "Kindorf" Corp.
   - iv or equal.

d. Beam Clamps:
   - i Cooper B-Line
   - ii SuperStrut
   - iii Unistrut
   - iv or equal.

e. Aircraft Cable Sway Braces:
   - i Mason Industries
   - ii M.W. Vibrex/Saussé
   - iii Loos & Company, Inc.
   - iv or equal.

C. Concrete Fasteners
   1. Provide expansion-shield type concrete anchors.
   2. Provide powder driven concrete fasteners with washers. Obtain approval by Owner's Representative prior to use.

D. Concrete Inserts
   1. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

E. Aircraft cable sway braces
   1. Steel rope sized to meet load.

F. Construction Channel:
   1. Construction:
      a. 1-5/8" square galvanized channel formed from U.S.S.G No. 12 or 0.109 inch cold formed steel with 17/32" diameter bolt holes, and 1-1/2" on center in the base of the channel.
      b. 10' sections.
   2. All supporting materials by same manufacturer.

B. Shoring: Comply with earthwork section of specifications.

C. Cleaning of Trenches: After pipe lines have been tested, inspected, and approved, and prior to backfilling, remove forms, trash, and debris from trenches, then backfill.

D. Backfill and Compaction: Comply with earthwork section of specifications.

3.4 CLEANING

A. Thoroughly clean exterior and interior of piping, equipment, and materials before systems are put in operation. Clean plumbing fixtures with soap and water. Remove marks and labels. Clean and polish chrome. Remove paint, concrete, plaster, and other foreign materials. Clean valve handles and stems of any paint, dirt, or other foreign materials. Clean drains of dirt and debris. Remove shipping paper from cleanout covers and polish. Remove and clean out dirt and debris from pipe spaces, including wire and blocking.

3.5 TESTING

A. Soil, waste and vent piping: Test with minimum height of stand pipe 10’-0”. Test duration to be a minimum of four (4) hours.

B. Rainwater leader and overflow drainage piping: Test with minimum height and stand pipe 10'-0". Test duration to be a minimum of four (4) hours.

C. Cold water, hot water and hot water return piping: Hydrostatically test under pressure of 150 psi at highest point for a minimum test duration of four (4) hours.

D. Gas piping: Test with air under pressure of 100 psi for a minimum test duration of four (4) hours.

E. Condensate drainage piping - mechanical equipment and condensing water heater: Test with a minimum height of stand pipe 10'-0". Test duration to be a minimum of four (4) hours.

F. If systems are tested in sections, include connection to previously tested section. Final pressures at end of test period shall be no more nor less than that caused by expansion or contraction of test medium due to temperature changes. Apply tests for a minimum period of four (4) hours or as required by local codes or agencies having jurisdiction. Where testing pressures are higher than rated pressure for equipment, or special trim, remove and bypass item with temporary piping for purposes of test.

G. Testing shall be done in the presence of the Owner's representatives.

3.6 PIPING IDENTIFICATION

A. Installation:

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

G. Beam Clamps
   1. Malleable iron electro-galvanized steel beam clamps selected to match building structural steel members.

H. Conduit Straps
   1. One hole strap, steel or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
      a. Use malleable strap with spacers for exterior and wet locations.
      b. Use steel strap without spacers for interior locations.
   2. Steel channel conduit strap for support from construction channel.
   3. Steel conduit hanger for pendant support with threaded rod
   4. Steel wire conduit support strap for support from independent #12 gauge hanger wires.

I. Threaded rods, couplings, screws and nuts:
   1. Electrolytically coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

J. Miscellaneous Parts
   1. Hot dipped galvanized after fabrication; after cutting, de-burring and hole drilling. Coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

K. Paint/Tape for Touch-up:
   1. Zinc: CRC "Zinc-It", Glyptal, Enterprise Galvanizing “Galambra”, or equal.

PART 3 - EXECUTION

3.1 Inspection of Conditions

A. Examine related Work and surfaces before starting Work of this Section. Report to the Architect, in writing, conditions which will prevent proper provision of this work. Beginning the Work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.

3.2 General Installation Requirements

A. Vibration Isolation: Mechanical and associated electrical machinery, piping and ductwork shall be mounted on vibration isolators and seismic snubbers as indicated or specified and required to minimize transmission of vibrations and structure borne noise to the building structure or spaces. All mechanical equipment, unless otherwise noted, shall be isolated from the structure by means of resilient vibration and noise isolators. Comply with minimum static deflections recommended by ASHRAE, of vibration isolation materials and units where not otherwise indicated.
   1. Rotating and reciprocating machinery shall be balanced statically and dynamically.

B. Stress: Installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment

C. Plastic nameplates: Install with corrosive-resistant mechanical fasteners or adhesive.

D. Plastic pipe markers: Install in accordance with manufacturer's instructions. Maximum spacing is to be twenty (20) feet on center.

E. Valves: Identify valves in main and branch piping with tags.

F. All exposed piping and piping above accessible ceilings shall be neatly identified spaced not more than twenty (20) feet on center.

3.7 STERILIZATION OF WATER MAINS

A. At the completion of all work and after the system is tested, flushed, and cleaned, all potable water lines shall be sterilized in accordance with local Department of Public Health, "AWWA" Standard C601, and the following:

B. Water treatment firm shall be Bennett Marine Utility, Inc., Burlingame, California, or equal.

C. A solution of sodium hypochlorite containing not less than 200 ppm of free chlorine shall be injected into the system in such a manner as to insure that the entire system is completely filled with the solution. During this procedure, all valves shall be operated and outlets shall be tested for residual chlorine. Injection shall continue until all outlets indicate at least 200 ppm of free chlorine.

D. After injection, the system shall be isolated and the solution held in retention for a period of not less than three (3) hours. Tests shall be made for residual chlorine for retention. If such tests indicate less than 200 ppm of residual chlorine, the entire procedure shall be repeated. After satisfactory sterilization has been effected, the system shall be flushed from an approved source, until all traces of chlorine have been removed or until the chlorine content is no greater than that in the existing supply.

E. A Certificate of Sterilization/Chlorination, together with bacteriological reports, shall be prepared by the water treatment firm and delivered to the Architect and mechanical engineer stating the work has been done in accordance with the specifications set forth above and prior to final acceptance by Owner. Provide copy of certificate to the Owner's representative.

END OF SECTION

of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Prior Approval: The Contractor shall not install any equipment, duct or piping which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to slabs, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems.

D. Rigid Contact: Prior to installation, the Contractor shall bring to the Architect's attention any conflicts between trades which will result in unavoidable rigid contact at equipment or piping or ducts, as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

E. Discrepancies: Prior to installation, the Contractor shall bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

F. Protection: Isolators exposed to the outdoors during construction shall either be designed for such exposure or shall be protected be suitable means.

G. Access: The Contractor shall obtain inspection and approval from the Architect of any installation to be covered or enclosed, prior to such closure.

H. Instructions: The Contractor shall obtain written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices; alternatively, the equipment may be installed by the vibration isolation manufacturer.

I. After installation and before equipment start-up an authorized representative of the manufacturer shall visit the site, and shall inspect each isolator and certify in writing that each is installed in accordance with the manufacturer's instructions. Make all adjustment and corrections required by the manufacturer's representative to enable this certification.

J. Defective Installations: The Contractor shall correct, at no additional cost to the Owner, all installations which are deemed defective in workmanship or materials by the Architect or Consultant.

K. Field Quality Control
   1. Testing and Inspection: See Section 01 45 00.
   2. Testing of Concrete Anchors: Anchors drilled into concrete and which are to be loaded in tension (pull-out) will be proof-tested by the Owner to two times the maximum allowable load. 50% of all anchors will be proof-tested. In the event of a single failure, testing of all remaining anchors will be performed as directed by the Architect. Additional testing required because of a test failure shall be paid for by the Contractor.
   3. Field Balancing:
      a. Dynamic balancing of certain critical rotating equipment is required.
         i Maximum Permissible Machinery Vibration Levels:
            1. Mechanical balance of rotating equipment as shown shall

be field tested with final drives and couplings in place and with the units in normal operation.

ii Overall vibration amplitude 0.003” maximum peak-to-peak, for frequencies below 10 cycles/second (600 rpm) and 0.1-inch/second maximum peak velocity for frequencies above 10 cycles/second (600 rpm).

iii Take measurements on bearing housings (not end caps) or other heavy structural element directly connected to bearing housing at both ends of each unit.

iv Pulley runout in radial and axial directions shall be less than 0.001”

v Correct and retest equipment exceeding the limits for compliance.

3.3 Equipment Isolators

A. Structural Frames: Machine to be isolated shall be supported by a structural steel frame, Type RS, Type CI, Type BR, Type TS, Type RPA or Type IRSF frames as described herein.

B. Brackets: Brackets shall be provided as required to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket shall be submitted by the isolator manufacturer.

C. Clearance: Operating clearance between the bracket and the pad or floor shall be 3/8" " 1/16". The minimum operating clearance between the frame and the housekeeping pad or floor shall be 1", for rigid steel and 2" for concrete inertia base.

D. Shims: Frame shall be placed in position and the brackets supported temporarily by 3/8" shims prior to the installation of the machine or isolators.

E. Support: Isolators shall be installed without raising the machine and frame assembly.

F. Adjustment: Adjusting after the entire system installation is completed and under full operation load, the isolator shall be adjusted so that the load is transferred from the shims to the isolator. When all isolators are properly adjusted, the shims will be barely free and shall be removed. Thereafter, the shims will be used as a gauge to check that the 3/8" clearance is maintained so that the system will remain free of stress.

G. Roof curbs: Installation of Type IRSF shall be in strict conformance with the manufacturer's instructions.

3.4 Installation Requirements, Motion Restraints

A. Inspection: All installations shall be inspected and approved by a Civil or Structural Engineer licensed in the Project jurisdiction for adequate motion restraint and to assure that such does not short-circuit vibration isolators during normal operation. Adjustments, as reasonably required, shall be made by the Contractor at no expense to the Owner.

B. RPA: Independent Motion Restraint for type RPA shall be bolted directly to the support surface and to the equipment frame as indicated in the approved shop drawings. Vertical height restraint bolts shall be utilized to stabilize RPA during mounting and installation,

and then disengaged. Following initialization of the unit to operating load, the height adjustment bolts shall be used to achieve final leveling at operating height. Install the specified independent Motion Restraint at this level, with a minimum of 1/8" clearance between restraint elements under normal operation. Manufacturer's instructions in this regard shall be explicitly conformed to. Following installation of Motion Restraint, vertical height restraint bolts provided with RPA shall be removed by cutting.

3.5 Piping Resilient Support and Suspension

A. Applies: Pipes included under this Section of the Specifications are refrigeration and heating water and all domestic water piping including that connected to vibrating equipment.

B. Does Not Apply: Piping not included is compressed air, piping not listed above, and fire standpipe and sprinkler piping.

C. Extent: Pipes and ducts connected to vibrating equipment shall be resiliently supported or suspended for a distance of 30 feet from such equipment. Refer to Part 2 for products. All connections to such equipment include flexible connections specified elsewhere in this Section in minimum lengths conforming to the recommendations in Table 43, Chapter 47, ASHRAE 2003 HVAC Applications.

D. Spring Hangers:
   1. Suspension Isolators shall be installed with the isolator hanger box as close as possible to the structure. Such isolators shall be suspended from substantial structural members, not from slab diaphragms unless specifically approved.
   2. Hanger rods shall be aligned to clear the hanger box.

E. Domestic Water: Domestic water piping not connected to vibration equipment shall be resiliently supported by the products listed under Part 2, in accordance with the manufacturer's instructions.

3.6 Installation Requirements, Flexible Piping Connections

A. Application: Flexible piping connections shall be installed within 10' of all vibrating equipment, or prior to penetration of the building, whichever is shorter, on all piping connected to such equipment.

B. Placement: Flexible piping connections shall be located such that their length is at right angles to the principal direction of movement and thus such that the movement of the equipment does not alternately place the connection into tension and compression.

C. Length: Flexible piping connectors shall be installed in accordance with the manufacturer's recommended procedures and in lengths complying with section 3.5.C.

D. Braided metal hose: Where permitted as a substitution, shall be installed in pairs, one in the vertical plane and one in the horizontal plane at each location that a single flexible pipe is required in this section.

3.7 Installation Requirements, Resilient Penetrations

A. Application: Penetrations included in this Section of the Specifications include all piping and ducts connected to vibrating equipment within 30' of such equipment.

B. Alternate A for round or rectangular penetrations:
   1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below and vertical framing between and to the sides, as required. Provide the above, escutcheon plates and such related construction as is necessary to make the penetrated structure as solid and massive near the penetrations as the surrounding construction.
   2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster or drywall compound full depth and all around – but only to a maximum width of 1/2" – or the requirements of the above paragraph shall not have been satisfied.
   3. Pack annular opening with glass fiber between metal sleeve and penetrating element full depth, all around to a firm degree of compaction. Leave a 1/2" deep annular opening free at each end of the metal sleeve; fill this fully with sealant.

C. Alternate B for round penetrations: Observe requirements above, except that use of sealant at sleeve ends is not required. In lieu of sealant, clamp factory-fabricated sleeve assemblies specified in Part 2 tightly around penetrating elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before sealing of sleeves to penetrated constructions. Refer to manufacturer's instructions for installation of fire-rated rubber link systems.

3.8 Mechanical Room/Plenum Requirements

A. Airtight Enclosure: All mechanical rooms, plenums, duct shafts and drywall duct enclosures shall be constructed airtight. This means that every precaution shall be taken to maintain construction completely airtight around a room so designated. Construction joints, duct penetrations, electrical boxes, frames, supports, cabinets, doors, access panels, fixtures, etc., all shall be built or installed in such a manner as to prevent sound transmission through any construction enclosing a room horizontally or vertically. Appropriate lintels, frames, blocking, escutcheons, grouting, gaskets, packing, caulking, taping, filling, etc., all shall be employed to prevent sound transmission. Refer to requirements of this Section for Resilient Penetrations.

B. Discrepancies: All work under this section is to comply with the above. Mechanical Contractor to report to architect any construction conditions which arise which might compromise compliance with this requirement.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work shall consist of furnishing all labor, material, and equipment required to complete the installation of the heating, ventilating, and air conditioning (HVAC) systems as indicated on the Drawings and described herein, including all incidental work necessary to make it complete and satisfactory and ready for operation.

B. Work shall include, but not be limited to, the following principal items:
1. Variable refrigerant flow system:
   a. Variable refrigerant flow outdoor unit.
   b. Variable refrigerant flow fan coil units.
   c. Variable refrigerant flow branch controllers.
   d. Variable refrigerant flow controls.
2. Exhaust fans.
3. Supply fans.
4. Cabinet supply fans.
5. Split air conditioning system.
6. Gravity hoods.
7. Refrigerant piping.
8. Filters.
9. Air distribution equipment including grilles, registers, and diffusers.
10. Ductwork systems complete with necessary volume dampers, access doors, hangers, supports, and accessories for the following service:
    a. Air supply.
    b. Air exhaust.
    c. Air return.
    d. Air transfer.
11. Insulation and covering for duct, piping and equipment.
12. Access panels and doors in ductwork and plenums.
13. Access panels in ceilings which relate to this trade, furnishing shop drawings, and coordination for the proper location of the panels.
14. Miscellaneous, including instruments, sleeves, flashings, tags and markings, and all accessories and items necessary for a complete installation.
15. Testing and adjusting all system components.
16. Testing and balancing of all air systems.
17. Complete control systems including:
    a. Thermostats.
    b. Sensors.
    c. Low voltage wiring.
    d. Coordination with other trades to ensure required work is completed.

e. Check-out and commissioning of control systems to verify sequences of operation are in accordance with the drawings.

1.3 RELATED SECTIONS

A. Plumbing Systems, Section 22 00 00.

B. Electrical, Division 26.

C. Wood & Plastics, Division 06.

D. Openings, Division 08.

E. Trenching, Division 31.

F. Acceptance Requirements, Section 23 05 00.

1.4 GENERAL REQUIREMENTS

A. Verification of Conditions: Prior to installation of heating, ventilating, and air conditioning work, inspect all surfaces to receive said work and arrange for the satisfactory correction of all defects in workmanship and/or material that could interfere with the work specified herein. Installation of any air conditioning work or materials on any surface shall constitute acceptance of such surfaces as being in proper condition to receive herein specified materials.

B. Codes: Work and materials shall be in full accordance with all applicable local or state ordinances, California Building Code, California Mechanical Code, National Fire Protection Association, State of California Safety Orders, and State Fire Marshal. Whenever Drawings and Specifications require larger sizes or higher standards than are required by regulations, Drawings and Specifications govern. Whenever Drawings or Specifications require something, which will violate regulations, regulations govern. No extra charge will be paid for furnishing items required by regulations but not specified or shown on Drawings.

C. Reference Standards: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this Section where cited below:
1. Air Moving and Conditioning Association (AMCA).
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Plumbing Engineers (ASPE).
5. Associated Air Balance Council (AABC).
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA).
8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
9. California Building Code (CBC).
10. State of California - OSHA.
11. California Mechanical Code (CMC).

12. The State of California Codes and Safety Orders.
13. 2013 California Building Energy Efficiency Standards (Title 24).
14. State Fire Marshal requirements (SFM).
15. Air Conditioning and Refrigeration Institute (ARI).
16. State of California Environmental Quality Act.
17. American Society of Testing and Materials (ASTM).
18. Underwriters Laboratories (UL).
19. Occupational Safety and Health Act (OSHA).
20. National Bureau of Standards (NBS).
21. American National Standards Institute (ANSI).
22. AMCA Standard 99: Standards Handbook.
23. AMCA/ANSI Standard 204: Balance Quality and Vibration Levels for Fans.
24. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings.
25. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans.
26. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters.
27. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil.
28. ANSI/ASHRAE 15: Safety Code for Mechanical Refrigeration.
29. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
30. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
31. ASME Section VIII: Unified Pressure Vessel Code.
32. UL Standard 1995: Heating and Cooling Equipment.
33. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
34. ASHRAE Standard 62.1-2013: Ventilation For Acceptable Indoor Air Quality.
35. ANSI/ASHRAE Standard 55-2013: Thermal Environmental Conditions for Human Occupancy.

D. Materials and workmanship:
1. All materials and equipment to be new and in perfect condition. Materials or equipment for similar uses are to be of same type and manufacturer.
2. Workmanship shall be of best standard practice of the trade.

E. Protection of equipment: The Contractor shall be responsible for any damage to any of the work of this Section until final acceptance. Cover all duct, pipe and equipment openings, and cover all apparatus, equipment, and appliances both before and after being set in place to prevent misuse or disfigurement of the apparatus, equipment, or appliances.

F. Openings:
1. Cooperate with other trades in providing information as to openings required in walls, floors, and roof for ducts and equipment.
2. Pay all extra costs for cutting of openings as a result of incorrect, delayed, or neglected information.
3. Make absolutely watertight any openings through waterproofed construction caused by the penetration of ductwork or piping, in a manner approved by the Architect.

G. Cleanup:
   1. Thoroughly clean all parts of the apparatus and equipment. Exposed parts, which are to be painted shall be thoroughly cleaned of cement, plaster, and other materials, and all grease and oil spots removed with cleaning solvent.
   2. Inside of all pipes, ducts, etc., shall be flushed or cleaned before being placed in operation, and all strainers shall be cleaned after operational tests.
   3. Remove all debris and surplus equipment and leave installation in perfect condition ready for use.

H. Construction review:
   1. All services rendered by the Architect or any of his consultants consist of professional opinions and recommendations made in accordance with generally accepted architectural practice.
   2. Under no circumstances is it the intent of the Architect or any of his consultants to directly control the physical activities of the Contractor or the Contractor's workmen in the accomplishment of the work.
   3. The presence of the field representative of the Architect or any of his consultants at the site is to provide to the Owner and/or Architect an additional source of professional advice, opinions, and recommendations based upon the field representative's observations.

I. Safety:
   1. In accordance with generally accepted construction practices, the Contractor will be solely and completely responsible for conditions on the project site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited by normal working hours.
   2. Construction review by the Architect or any of his consultants is not intended to include review of the adequacy of the Contractor's safety measures in, on, or near the project site or at any other location.

J. Welder's Qualifications:
   1. All welding must be performed by registered welders qualified to perform welding operations in accordance with ASME Code Standards.

1.5 SUBMITTALS

A. Refer also to Division 01 for additional submittal requirements.

B. When specific names are used in connection with materials, they are used as standards only, but this does not imply the right to use other materials or methods unless approved by the Architect.

C. Decision of the Architect shall govern as to what materials are acceptable substitutions. Burden of proof as to equality of any proposed fixtures, material, or equipment shall be upon the Contractor. Petition in favor of proposed substitute materials shall be made directly by the Contractor. If any tests are necessary to determine equality of proposed items, such tests shall be made at the expense of the Contractor by an unbiased laboratory satisfactory to the Architect.

D. Submit shop drawings and material list in six (6) copies. Submit material list and shop drawings after official award of contract. Obtain approval of the Architect before installation. Shop drawings shall be submitted for all materials, equipment, and controls.

E. Check shop drawings and submittals before forwarding to Architect and ascertain that submittals meet all requirements of drawings and specifications and conform to structural conditions available.

F. Shop drawings also shall be prepared for modifications to architectural, structural, plumbing, electrical, and mechanical work required by proposed materials - i.e., relocation of drains, revised electrical circuits, relocation of penetrations, etc.

G. Installation of any approved substituted equipment is the Contractor's responsibility, and any changes required to work included under other sections for installation of approved substituted equipment must be made to the satisfaction of the Architect and without any additional cost. Approval by Architect of substituted equipment and/or dimension drawings does not waive these requirements.

H. Review of drawings and materials submitted for approval shall not be construed as a complete check or constitute a waiver of the requirements of the drawings and specifications but will indicate that the material submitted is acceptable in quality, utility, and capacity. This review shall not relieve the Contractor of the responsibility to fit the proposed materials to the spaces provided and to effect necessary rearrangement or construction of other work. Contractor agrees that shop drawing submittals processed by the Architect do not become contract documents and are not change orders; that the purpose of the shop drawing review is to establish a reporting procedure and is intended for the Contractor's convenience in organizing his work and to permit the Architect to monitor the Contractor's progress and understanding of the design. If deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents are discovered either prior to or after the shop drawing submittals are processed by the Architect, the Contractor agrees that the contract documents shall control and shall be followed.

I. Submittal lists shall include the identifying marks assigned to the items. Give name of manufacturer, brand name, and catalog number of each item. Submit complete list at one time with items arranged and identified in numerical sequence within each section and article of the specifications. Listing items "as specified" without both make and model or type designation is not acceptable except pipe and pipe fittings not specified by brand names, which may be listed "as specified" without manufacturer's name, provided proposed materials comply with specification requirements.

J. Descriptive Data: Submit complete description, information, and performance data covering equipment which is specified but for which catalog plate numbers, brand names, or specific models have not been used. Include fan performance curves for all equipment with fans and for each individual fan submitted.

K. Submittal of substitutions shall be limited to one (1) proposal for each type or kind of item, unless otherwise permitted by the Architect.

1.6 DRAWINGS, SPECIFICATIONS, AND COORDINATION OF WORK

A. Drawings are essentially diagrammatic. Size and locations of equipment are generally shown to scale. Make use of data in all contract documents, and verify this information against field conditions.

B. The drawings indicate the required size and point of termination of ductwork, pipes, and equipment. Install pipe with all necessary offsets and fittings to conform to the structure, avoid obstructions, preserve headroom, maintain required accessibility, and satisfy the requirements of the governing codes and the standards of good practice.

C. The architectural and structural drawings and specifications take precedence over the mechanical drawings in the representation of the general construction work. Refer to the drawings, specifications, and review shop drawings for all work in order to coordinate mechanical work with the other work of the project.

D. Where changes in indicated locations or arrangements are necessary due to conditions in building construction, rearrangement of equipment, or conflict in location, make such changes at no cost to the Owner, provided that the change is ordered before pipe ductwork and/or equipment is installed and that the length of run is not revised by more than 5 percent of the indicated run.

E. Bring discrepancies between different drawings, between drawings and actual field conditions, or between drawings and specifications promptly to the attention of the Architect for decision, and stop all work on affected areas subject to resolution of the conflict.

1.7 OPERATING INSTRUCTIONS

A. Comply with the requirements of Division 01 – General Requirements.

B. Upon completion of the work, the Contractor shall place a competent person in charge who will operate the system and instruct the Owner's representatives in all details of the operation and maintenance of each piece of equipment and each system.

C. The Contractor shall carefully prepare four (4) descriptive binders of the entire heating, ventilating, and air conditioning systems and a full description of the operation and maintenance of each piece of equipment. The binders shall have tabs indicating each type of equipment with sub-dividers indicating the equipment symbol shown on the drawings. An index shall be provided with page numbers for each type of equipment and each piece of equipment. The binders shall be well organized to provide easy reference.

D. Operating instruction manuals are to include names, addresses, and telephone numbers for the following: project name, Owner, Mechanical Contractor, and equipment manufacturers (including local representatives).

1.8 GUARANTEE

A. This Contractor shall furnish a written guarantee to the Owner that the materials, equipment, and installation are new, free from mechanical defects, noiseless, and are in perfect operating condition.

B. He shall guarantee to replace and repair at his own expense any and all unsatisfactory and defective work and items to the satisfaction of the Owner for a period of at least one (1) year after the system is put to beneficial use and for longer periods as specified.

C. The Contractor shall also furnish the Owner with all manufacturers' written guarantees of materials and equipment.

D. See also Division 1.

1.9 RECORD DRAWINGS

A. Comply with the requirements of Division 01 – General Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Access doors:
   1. General: All concealed equipment, valves, controls, fire/smoke dampers, volume dampers, etc., shall be provided with access doors which shall be furnished and installed by the general Contractor. Coordination for the location of access doors to ensure access to all HVAC equipment requiring access is the responsibility of this section of work. Access doors are not required in removable ceilings. Access doors which provide access to fire/smoke dampers are to be labeled with one-half inch (1/2") high letters reading "Fire/Smoke Damper."
   2. Access doors shall be bonderized steel, with flush screwdriver operated cam latch, fitted with concealed hinges, factory prime coated. Doors shall be Milcor, or equal, Style "A" for acoustical tile, Style "B" for acoustical plaster, Style "K" for non-acoustical plaster, and Style "M" elsewhere, 24" square unless otherwise noted on the Drawings. Access doors in 1 or 2-hour construction shall be Milcor or equal U/L "B" label doors.

B. Air diffusers, grilles, and registers:
   1. Provide opposed blade damper volume controls only where specifically scheduled on the Drawings.
   2. Contractor to verify that the mounting frame of ceiling diffusers, grilles, and registers matches the ceiling or wall system actually being installed. Color to be standard off-white.
   3. All air diffusers, grilles, and registers are to be as shown on the Drawings.
   4. Manufacturer: Titus, Price, or equal.

2.2 EQUIPMENT

A. Variable Refrigerant Flow System:
1. General
a. System Description:
1) The variable refrigeration flow system shall be a Mitsubishi Electric CITY MULTI Variable Refrigerant Flow (VRF) System or equal. The CITY MULTI VRF systems shall be the R2-Series (simultaneous cooling and heating) heat pump.
2) The R2-Series system shall consist of a PURY outdoor unit, BC (Branch Circuit) Controller, multiple indoor units (-E models), and M-NET DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. To ensure power comfort, each indoor unit or group of indoor units shall be independently controlled and capable of changing mode automatically when zone temperature strays 1.8 degrees F from set point for ten minutes. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.
b. Quality Assurance:
1) The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
2) All wiring shall be in accordance with the National Electrical Code (N.E.C.).
3) The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
4) All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
5) A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
c. Delivery, Storage and Handling:
1) Unit shall be stored and handled according to the manufacturer's recommendation.
d. Warranty:
1) The units shall be covered by the manufacturer's extended limited warranty for a period of five (5) years from date of installation.
2) The refrigeration compressors shall have a manufacturer's limited warranty for a period of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at no cost to the Owner.
e. Qualifications of Installer

1) The CITY MULTI VRF system shall be installed by a Mitsubishi authorized CITY MULTI Diamond Dealer with extensive CITY MULTI installation and service training with a minimum of two (2) installations completed of similar size and complexity to this project. The mandatory Contractor service and install training shall be performed by the manufacturer. The installing Contractor shall submit proof of participating in and successfully completing the manufacturer's training program prior to ordering any equipment or proceeding with any work on this project. The installing Contractor must also submit a list of the CITY MULTI VRF Systems that they have installed.

f. Manufacturer Start-Up Services

1) An authorized representative of the Variable Refrigerant Flow System manufacturer is to inspect the installation and control functioning of the variable refrigerant flow system and provide start-up services. The representative is to provide a letter certifying that the installation meets their requirements and that the variable refrigerant flow system is fully operational.

2. R2-Series Outdoor Unit:

a. General:

1) The R2-Series PURY outdoor unit shall be used specifically with CITY MULTI VRF components. The PURY outdoor units shall be equipped with multiple circuit boards that interface to the M-NET controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

a) All units requiring a factory supplied twinning kit shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the Contractor.

b) Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 63 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the Contractor.

c) Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller (Single or Main) shall be insulated.

d) There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.

e) Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.

f) The outdoor unit shall have an accumulator with refrigerant level sensors and controls.

g) The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.

h) The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 1804-2625 feet. The greatest length

is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.

i) The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature or cooling mode down to 23°F ambient temperature, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the Contractor.

j) The outdoor unit shall be provided with a manufacturer supplied 20 gauge hot dipped galvanized snow/hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.

k) The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

l) Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend “no or reduced heating” periods shall not be allowed.

b. Unit Cabinet:

1) The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

c. Fan:

1) Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.

2) All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

3) All fan motors shall be mounted for quiet operation.

4) All fans shall be provided with a raised guard to prevent contact with moving parts.

5) The outdoor unit shall have vertical discharge airflow.

d. Refrigerant

1) R410A refrigerant shall be required for PURY outdoor unit systems.

2) Polyester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit Material Safety Data Sheets (MSDS) and comparison of hydroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

e. Coil:

1) The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

2) The coil fins shall have a factory applied corrosion resistant blue-fin finish.

3) The coil shall be protected with an integral metal guard.

4) Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

5) The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

f. Compressor:
1) Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors shall not be allowed.
2) A crankcase heater(s) shall be factory mounted on the compressor(s).
3) The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-8% of rated capacity, depending upon unit size.
4) The compressor will be equipped with an internal thermal overload.
5) The compressor shall be mounted to avoid the transmission of vibration.
6) Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

g. Electrical:
1) The outdoor unit shall be controlled by integral microprocessors.
2) The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

3. Branch Circuit (BC) Controllers for R2 Series Systems:

a. General:
1) The BC (Branch Circuit) Controllers shall include multiple branches to allow simultaneous heating and cooling by allowing either hot gas refrigerant to flow to indoor unit(s) for heating or subcooled liquid refrigerant to flow to indoor unit(s) for cooling. Refrigerant used for cooling must always be subcooled for optimal indoor unit LEV performance; alternate branch devices with no subcooling risk bubbles in liquid supplied to LEV and are not allowed.
2) The BC (Branch Circuit) Controllers shall be specifically used with R410A R2-Series systems. These units shall be equipped with a circuit board that interfaces to the M-NET controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
3) Each VRF system shall include at least one (1) unused branches or branch devices for future use. Branches shall be fully installed & wired in central location with capped service shutoff valve & service port.

b. BC Unit Cabinet:
1) The casing shall be fabricated of galvanized steel.
2) Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.

3) The unit shall house two tube-in-tube heat exchangers.

c. Refrigerant
   1) R410A refrigerant shall be required.

d. Refrigerant valves:
   1) The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
   2) Each branch shall have multiple two-position valves to control refrigerant flow.
   3) Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
   4) Linear electronic expansion valves shall be used to control the variable refrigerant flow.

e. Integral Drain Pan:
   1) An integral condensate pan and drain shall be provided.

f. Electrical:
   1) The BC Controller shall be controlled by integral microprocessors.
   2) The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

4. Variable Refrigerant Flow Fan Coil Units – Mitsubishi:

a. PMFY (1-Way Ceiling-Recessed Cassette With Grille) Indoor Unit
   1) General:
      a) The PMFY shall be a one-way cassette indoor unit that recesses into the ceiling with a ceiling grille and shall have a modulating linear expansion device. The PMFY shall be used with the R2-Series outdoor unit and BC Controller or Y-Series outdoor unit. The PMFY shall support individual control using M-NET DDC controllers.
      b) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
   2) Unit Cabinet:
      a) The cabinet shall be space-saving ceiling recessed.
      b) The cabinet panel shall have provisions for a field installed filtered outside air intake.
      c) Branch ducting shall be allowed from cabinet.
      d) The one-way grille shall be fixed to bottom of cabinet allowing for one-way airflow.
   3) Fan:
      a) The indoor fan shall be an assembly with one line-flow fan direct driven by a single motor.
      b) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.

c) The indoor fan shall consist of four (4) speeds, Low, Mid1, Mid2, and High.

4) Filter:
   a) Return air shall be filtered by means of a long-life washable permanent filter.

5) Coil:
   a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b) The tubing shall have inner grooves for high efficiency heat exchange.
   c) All tube joints shall be brazed with phos-copper or silver alloy.
   d) The coils shall be pressure tested at the factory.
   e) A condensate pan and drain shall be provided under the coil.
   f) The unit shall be provided with an integral condensate lift mechanism able to raise drain water 23 inches above the condensate pan.
   g) Both refrigerant lines to the PMFY indoor units shall be insulated.

6) Electrical:
   a) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

7) Controls:
   a) This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.
   b) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
   c) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8 degree F deadband from set point.

8) Provide all options and accessories as scheduled on the drawings.

b. PEFY-NMAU Ceiling-Concealed Ducted Indoor Unit

1) General:
   a) The PEFY-NMAU unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge and shall have a modulating linear expansion device. The PEFY-NMAU shall be used with the R2-Series outdoor unit and BC Controller, and the Y-Series outdoor unit. The PEFY-NMAU shall support individual control using M-NET DDC controllers.

2) Indoor Unit.
   a) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring,

piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

3) Unit Cabinet:
   a) The cabinet shall be ceiling-concealed, ducted.
   b) The cabinet panel shall have provisions for a field installed filtered outside air intake.
4) Fan:
   a) PEFY-NMAU unit shall have external static pressure settings from 0.14 to 0.60 in. WG.
   b) The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
   c) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   d) The indoor unit shall have a ducted air outlet system and ducted return air system.
   e) The indoor fan shall consist of three (3) speeds, high, mid, and low plus the auto-fan function.
5) Filter:
   a) Return air shall be filtered by the optional (to be provided) filter box.
6) Coil:
   a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b) The tubing shall have inner grooves for high efficiency heat exchange.
   c) All tube joints shall be brazed with phos-copper or silver alloy.
   d) The coils shall be pressure tested at the factory.
   e) A condensate pan and drain shall be provided under the coil.
   f) The condensate shall be gravity drained from the fan coil.
   g) Both refrigerant lines to the PEFY indoor units shall be insulated.
7) Electrical:
   a) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
8) Controls:
   a) This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
   b) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8 degree F deadband from set point.
9) Provide all options and accessories as scheduled on the drawings.

c. PVFY (Multi-Postion Upflow) Indoor Units
   1) General
      a) The PVFY shall be a multi-position ducted indoor fan coil design with a fixed return, a fixed discharge supply, and a modulating linear expansion device. The unit shall have the

capability to be mounted in either the vertical or horizontal (left position only) and have the capability to integrate into systems with various types of indoor units connected. The PVFY shall be used with the R2-Series outdoor unit and BC Controller. The PVFY shall support individual control using M-NET DDC controllers. Units shall have the ability to control supplemental heat via connector Cn24 and a 12 VDC output.

b) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

2) Unit Cabinet:
   a) The cabinet shall be pre-painted, pre-insulated, 22 gauge galvanized steel.
3) Fan:
   a) The indoor unit fan shall be an assembly with a single direct drive fan with a high efficiency DC motor.
   b) The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
   c) The indoor unit shall have a ducted air outlet system and ducted return air system.
   d) The fan shall have 3-speeds with the capability to operate between 0.3-0.5 In.W.G. selectable.
4) Filter:
   a) Mixed air shall be filtered by a standard factory installed filter.
5) Coil:
   a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b) The tubing shall have inner grooves for high efficiency heat exchange.
   c) All tube joints shall be brazed with phos-copper or silver alloy.
   d) The coils shall be pressure tested at the factory.
   e) A condensate pan and drain shall be provided under the coil.
   f) The condensate shall be gravity drained from the fan coil.
   g) Both refrigerant lines to the PVFY indoor units shall be insulated.
6) Electrical:
   a) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
7) Controls:
   a) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8 degree F deadband from set point.

d. PFFY (Floor Mounted) Indoor Units
   1) General:
      a) The PFFY shall consist of a floor-standing indoor section with and have a modulating linear expansion device. The PFFY shall be used with the R2-Series outdoor unit and BC Controller. The PFFY shall support individual control using M-NET DDC controllers.
      b) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
   2) Unit Cabinet, Exposed:
      a) The casing shall have a beige Acrylic paint finish.
   3) Fan:
      a) The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
      b) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
      c) The indoor fan shall consist of two (2) speeds, High and Low.
   4) Filter:
      a) Return air shall be filtered by means of an easily removable washable filter.
   5) Coil:
      a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
      b) The tubing shall have inner grooves for high efficiency heat exchange.
      c) All tube joints shall be brazed with phos-copper or silver alloy.
      d) The coils shall be pressure tested at the factory.
      e) A condensate pan and drain shall be provided under the coil.
      f) Both refrigerant lines to the PFFY indoor units shall be insulated.
   6) Electrical:
      a) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
      b) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
   7) Controls:
      a) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8 degree F deadband from set point.

e. PLFY (Recessed ceiling 4-way) indoor unit
   1) General:
      a) The PLFY shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit

shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

2) Unit Cabinet:
   a) The cabinet shall be a compact 22-7/16” wide x 22-7/16” deep so it will fit within a standard 24” square suspended ceiling grid.
   b) The cabinet panel shall have provisions for a field installed filtered outside air intake.
   c) Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
3) Fan:
   a) The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
   b) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
   c) The indoor fan shall consist of three (3) speeds, Low, Mid, and High.
   d) The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
   e) The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.
4) Filter:
   a) Return air shall be filtered by means of a long-life washable filter.
5) Coil:
   a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
   b) The tubing shall have inner grooves for high efficiency heat exchange.
   c) All tube joints shall be brazed with phos-copper or silver alloy.
   d) The coils shall be pressure tested at the factory.
   e) A condensate pan and drain shall be provided under the coil.
   f) The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4” inches above the condensate pan.
   g) Both refrigerant lines to the PLFY indoor units shall be insulated.
6) Electrical:
   a) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
   b) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
7) Controls:

a) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
b) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
c) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
d) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
e) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.
f) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

f. PKFY (Wall Mounted) Indoor Unit
1) General:
a) The PKFY shall be a wall-mounted indoor unit section and shall have a modulating linear expansion device and a flat front. The PKFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PKFY shall support individual control using M-NET DDC controllers.
b) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
2) Unit Cabinet:
a) All casings, regardless of model size, shall have the same white finish
b) Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
c) There shall be a separate back plate which secures the unit firmly to the wall.
3) Fan:
a) The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.

b) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
c) A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
d) A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

4) Filter:
a) Return air shall be filtered by means of an easily removable, washable filter.

5) Coil:
a) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
b) The tubing shall have inner grooves for high efficiency heat exchange.
c) All tube joints shall be brazed with phos-copper or silver alloy.
d) The coils shall be pressure tested at the factory.
e) A condensate pan and drain shall be provided under the coil.
f) Both refrigerant lines to the PKFY indoor units shall be insulated.

6) Electrical:
a) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
b) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)

7) Controls:
a) The unit shall be able to control external backup heat.
b) The unit shall have a factory built in receiver for wireless remote control
c) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
d) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
e) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
f) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
g) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.
h) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be

produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

5. Variable Refrigerant Flow Controls – Mitsubishi:
   a. General:
      1) The CITY MULTI Controls Network (CMCN) shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Energy Management and Temperature Control System (EMTCS) via BACnet® and LonWorks®.
   b. Electrical Characteristics
      1) General:
         a) The CMCN shall operate at 24VDC. Controller power and communications shall be via a common non-polar communications bus.
      2) Wiring:
         a) Control wiring shall be installed in a system daisy chain configuration from indoor unit to ME remote controller to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
         b) Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply.
         c) Control wiring for the Deluxe MA, Simple MA, and Wireless MA remote controllers shall be from the remote controller to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration...
         d) The AG-150A, G-50A and GB-50A system controller shall be capable of being networked with other AG-150A, G-50A and GB-50A system controllers for web based control.
      3) Wiring type:
         a) Wiring shall be 2-conductor (16 AWG), twisted shielded pair, stranded wire, as defined by the Design Tool AutoCAD output.
         b) Network wiring shall be CAT-5e with RJ-45 connection.
   c. CITY MULTI Controls Network
      1) The CITY MULTI Controls Network (CMCN) consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with EMTCS using either LonWorks® or BACnet® interfaces.
   d. CMCN: Remote Controllers
      1) Deluxe MA Remote Controller (PAR-21MAA)
         a) The Deluxe MA Remote Controller (PAR-21MAA) shall be capable of controlling up to 16 indoor units (defined as 1

group). The Deluxe MA Remote Controller shall be approximately 5” x 5” in size and white in color with a light-green LCD display. The PAR-21MAA shall support a selection from multiple languages (Spanish, German, Japanese, Chinese, English, Russian, Italian, or French) for display information. The Deluxe MA supports temperature display selection of Fahrenheit or Celsius. The Deluxe MA Remote Controller shall control the following grouped operations: On/Off, Operation Mode (cool, heat, auto (R2-Series only), dry, and fan), temperature set point, fan speed setting, and airflow direction setting. The Deluxe MA Remote Controller shall support timer settings of on/off/temperature up to 8 times in a day in 1-minute increments. The Deluxe MA Remote Controller shall support an Auto Off timer. The Deluxe MA Remote Controller shall be able to limit the set temperature range from the Deluxe MA. The room temperature shall be sensed at either the Deluxe MA Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Deluxe MA Remote Controller shall display a four-digit error code in the event of system abnormality/error.

b) The Deluxe MA Remote Controller shall only be used in the same group with other Deluxe MA Remote Controllers (PAR-21MAA), Wireless MA (PAR-FL32MA / PAR-FA32MA), or Simple MA Remote Controllers (PAC-YT51CRB), with up to two remote controllers per group.

c) The Deluxe MA Remote Controller shall require no addressing. The Deluxe MA Remote Controller shall connect using two-wire, stranded, non-polar control wire to TB15 connection terminal on the indoor unit. The PAR-21MAA shall require cross-over wiring for grouping across indoor units.

e. GB-50A Centralized Controller:

1) The GB-50A Centralized Controller shall be capable of controlling via a PC a maximum of 50 indoor units across multiple CITY MULTI outdoor units. A field supplied PC shall be required for the GB-50A Centralized Controller. The GB-50A Centralized Controller shall be approximately 5”x11” in size and shall be powered from a Power Supply Unit (PAC-SC50KUA). The GB-50A Centralized Controller shall support operation superceding that of the remote controllers, system configuration, daily/weekly/annual scheduling, monitoring of operation status, error email notification, online maintenance tool and malfunction monitoring. The GB-50A Centralized Controller shall have basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the GB-50A Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2-Series only), dry, and fan), temperature setting, fan speed setting, airflow direction setting, error email notification, and online maintenance. Since the GB-50A provides centralized control it shall be able to enable or disable operation of local remote controllers via the PC. In terms of

scheduling, the GB-50A Centralized Controller shall allow the user to define daily, weekly, and annual schedules with operations consisting of ON/OFF, mode selection, temperature setting, and permit/prohibit of remote controllers.

2) All GB-50ADA Centralized Controllers shall be equipped with on RJ-45 Ethernet port to support interconnection with a network PC via closed/direct Local Area Network (LAN). The GB-50ADA Centralized Controller shall be capable of performing intial settings via a PC using GB-50ADA Centralized Controller's initial setting brower.

3) Standard software functions shall allow the building manager to securely log into each GB-50ADA via the PC's web browser to support operation monitoring, scheduling, error mail, and online maintenance diagnostics. Standard software functions shall not expire. Additional optional software functions shall be available of personal browser for PCs and MACs, Tenant Billing that requires TG-2000 Integrated System software in conjunction with GB-50ADA Centralized Controllers.

f. BAC-HD150: BACnet® Interface

1) The Mitsubishi Electric HVAC BACnet® interface, BAC-HD150, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.

B. Exhaust Fan:

1. Greenheck series G or equal direct drive, roof-curb mounted, centrifugal roof exhaust fan.
2. Fans shall have non-overloading, backwardly inclined, centrifugal wheels, birdscreens, direct drive motor and drive assembly, aluminum housing, backdraft damper, and disconnect switch, all completely weatherproofed for outdoor installation.
3. Provide all options and accessories as scheduled on the drawings.

C. Gravity Hoods:

1. Greenheck Fabrahood, or equal gravity roof hoods.
2. Precision formed, arched panels with interlocking seams. Curb cap to be 8" larger than throat size. 1/2" galvanized steel mesh mounted horizontally across the intake/discharge area of the hood. Galvanized steel support members fasten so that hood can either be completely removed from the base or hinged open.
3. Provide all options and accessories as scheduled on the drawings.

D. Supply Fans:

1. Supply fans are to be S&P model Tb-silent or equal. The fan housing shall be constructed of polypropylene, fan blades and shall be ABS, ball bearings shall be permanently lubricated and motor shall be two (2) speed.
2. Fans shall have the capacity and capabilities as scheduled on the drawings.
3. Provide all options and accessories as scheduled on the drawings.

E. Cabinet Supply Fan:
1. Direct drive cabinet supply fans are to be Greenheck Series SQ or equal.
2. The fan housing shall be constructed of heavy gauge galvanized steel and shall include pre-punched mounting brackets.
3. The fan housing interior shall be lined with 1/2” acoustical insulation.
4. The fan motor shall be mounted on vibration isolators.
5. Cabinet supply fans shall have the capacity and capabilities as scheduled on the drawings.
6. Provide all options and accessories as scheduled on the drawings.

F. Split Air Conditioning Systems:
1. The split air conditioning systems are to be ductless cooling only air conditioning systems with both indoor fan units and outdoor condensing units from both indoor fan coil units and outdoor condensing units from the same manufacturer.
2. The indoor fan coil units air to be Mitsubishi Type PKA or equal wall mounted units. The outdoor condensing units are to be Mitsubishi Type PUY or equal as scheduled on the drawings.
3. Cooling capacities are to be equal to or greater than the cooling capacities scheduled on the drawings.
4. Provide all options and accessories as scheduled on the drawings.

2.3 SYSTEMS

A. Air Distribution Duct Systems:
1. Sheet Metal Work:
a. 2,500 fpm, +2.0” SP to - 2.0” SP for supply, return, exhaust and transfer ducts.
b. General: Ductwork shall be round spiral lock seam or rectangular galvanized steel construction.
c. Duct Construction:
1) General: Construction shall be in accordance with the latest ASHRAE Standards, SMACNA 1995 - Second Edition with Addendum No. 1 November 1997 HVAC Duct Construction Standards, California State Mechanical Code, and the Title 24 energy standards.
2) All duct joints and seams are to be constructed to meet the requirements of the 1995 SMACNA HVAC Duct Construction Standards noted above. Manufactured joints, such as Ductmate or TDC, are to be installed in strict accordance with the manufacturer’s installation requirements.
3) Care shall be taken to ensure that all duct reinforcing requirements are met.
4) All 90° branch fittings for round ducts are to be of the conical tee type, conical saddle tap, or as detailed on the Drawings.
5) All spiral round duct and fittings inside buildings to be United McGill, Uni-Seal, or equal.
6) Spiral duct joints for diameters up to 36” are to be fabricated using sleeve type couplings. Galvanized steel “Uni-Rings” or angle iron rings are to be used for joints on ducts 36” diameter and larger.

7) Commercial gauge adjustable elbows may be used in concealed areas for duct sizes up through 14" diameter. For duct sizes greater than 14" diameter and where duct is exposed, elbows shall be United McGill "Uni-Seal" gored elbows or equal.
8) Flat oval duct is to be United McGil Uni-Seal or equal spiral lockseam flat oval duct and fittings. Joints are to be made using United McGil Duct-to-Duct couplings.
9) All spiral round and flat oval duct shall be installed in strict accordance with the manufacturer's requirements.
10) All rectangular duct, fittings and plenums are to be constructed in accordance with 1995 SMACNA, HVAC Duct Construction Standards noted above.
11) Provide galvanized steel angle ring, 2" wide at all locations where exposed ducts penetrate walls. Angle rings are to be installed to present a finished and aesthetically pleasing appearance.
12) All exposed duct, fittings, sealants and apparatus are to be installed suitable for painting.
13) All elbows and bends are to be made with the minimum inside radius equal to 1.5 times the duct diameter or centerline radius (R/W=1.5), where possible. If field conditions do not allow 1.5 inside radius, provide elbow and bend radius as long as possible. Elbow and bend radius shall be no less that that shown on the Drawings. All conditions with less than 1.5 inside radius must be approved by the Architect, prior to fabrication and/or installation.
14) Non-radius, square heel and throat rectangular elbows, with or without turning vanes, are not acceptable unless specifically shown on the Drawings.
15) All radius elbows in rectangular ductwork are to include one (1) splitter vane, located at a distance of 1/3 of the duct width as measured in from the elbow throat.

d. Ducts are to be sealed so as to conform to SMACNA Duct Seal Class C duct tape as a sealant is not acceptable. A brush applied, high pressure duct sealant is to be utilized, MEI or equal. Sealant is to be verified that it is suitable for painting. Sealant is to be applied in a neat manner in exposed duct locations. Duct sealant is to be applied in complete accordance with the manufacturer's application instructions.

e. Flexible Duct – Atco #036, R6.0, reinforced metalized polyester vapor barrier; or equal pre-insulated flexible duct may be used for final connection between ducts, grilles, and diffusers where shown on the Drawings. Maximum length of flexible duct to be six (6) feet. Duct is to be carefully supported to provide smooth air flow path and to prevent sagging. Flexible duct must meet UL 181, Class 1, factory made, air duct requirements, California State Fire Marshall Approved. Install in strict accordance with manufacturer's installation instructions. Duct insulation is to be a minimum of 1-1/2" thick, 3/4 pounds per cubic foot density. Flexible duct is to have mounting collars. Joints of flexible ducts with other ducts or registers are to be made with sheet metal screws.

f. All roof-mounted duct and/or ducts exposed to weather are to be constructed using roll-formed flanges with corner angles, gasket and cleats. Ductmate, TDC, TDF, or equal.

2. General:
   a. Access Doors: Doors in sheet metal ducts and plenums for access to dampers, extractors and equipment shall be No. 18 gauge, and made airtight by means of felt strips. Doors shall be sized as required for reasonable service access. Minimum size shall be 12” x 12” unless limited by duct size.
      1) Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
      2) Review locations prior to fabrications.
      3) Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening looking devices. For insulated ductwork, install minimum 1 inch thick insulation with metal cover.
      4) Access doors smaller than 12 inches square may be secured with sash locks.
      5) Provide 2 hinges and 2 sash locks for sizes up to 18 inches square, 3 hinges and 2 compression latches with outside and inside handles for sizes up to 24 x 18 inches.
      6) Access doors with sheet metal screw fasteners are not acceptable.
   b. Balancing Dampers: Shall be furnished and installed where required to completely balance and otherwise adjust the air quantities to each supply and return outlet, branch duct and exhaust grille. Manual balance dampers shall be provided in each branch duct. Balancing dampers shall not be installed in the collar of any flexible duct.
      1) Balancing dampers in rectangular ducts:
         a) Ruskin Model CD50 or equal low leakage damper with airfoil type extruded aluminum blade with a maximum depth of 6” and with an integral structural reinforcing tube running full length of each blade. Blade edge seals shall be extruded vinyl double edge design with inflatable pocket. Linkage shall be concealed in frame damper manufacturer’s literature shall include performance data developed from testing in accordance with AMCA Standard 500 in an AMCA approved laboratory showing pressure drop for all sizes of dampers required at all anticipated airflow rates.
      2) Balancing dampers in round ducts:
         a) Fabricate in accordance with SMACNA Duct Construction Standards and as indicated.
         b) Shall be furnished and installed where required to completely balance and otherwise adjust the air quantities to all supply and return outlets, branch ducts, and exhaust grilles. Manual balance dampers shall be provided in each branch duct. Damper to be one gauge heavier than the duct gauge. Provide Jiffy Bearings JB-1 damper hardware or equal.
         c) Except in round ductwork 12 inch and smaller, provide end bearings. On multiple blade dampers, provide oil impregnated nylon or sintered bronze bearings.
         d) On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases or adaptors.
   c. Painting: Paint the inside of all backs of diffusers, registers, grilles, ducts and dampers extending as far as visible with flat black paint.

d. Flexible connections for supply and return air ducts connections to the fan coil units and exhaust fans, and at all seismic building joints shall be 16 oz. airtight “Ventglass” or equal non-combustible fabric with fire retardant neoprene coating on outside. Attach to ductwork by lock seam. Install 6” long. Provide sheet metal rain cover over flexible connections exposed to the weather.

e. Ducts exposed to the weather are to be completely weatherproofed. All joints and seams are to be sealed using Hardcast Galva-Grip or equal weatherproof duct sealant. The manufacturer’s installation instructions are to be followed closely.

f. Duct test holes: Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Refrigerant Piping:

1. Refrigerant piping is to be ASTM B2800, Type “ACR” hard-drawn copper.
2. Joints are to be brazed using Silfos-5 or equivalent brazing material.

C. Mechanical Systems and Equipment Insulation:

1. Ducts:
   a. General:
      1) Adhesives and insulation materials: Composite fire and smoke hazard ratings maximum 25 for Flame Spread and 50 for Smoke Developed. Adhesives to be waterproof.
      2) Anti-microbial agent surface coating: EPA-registered biocide, ASTM C-1338, ASTM G-21, ASTM G-22.
   b. Insulation shall be provided on all duct where shown on the Drawings, all roof mounted supply, return, and outside air intake ducts, and all concealed supply and return ducts.
   c. Concealed duct: Cover all sides with 1-1/2 inch thick, 3/4 pounds per cubic foot density duct wrap with foil scrimkraft or approved equal, applied per the manufacturer’s application specification. Note that foil scrimkraft is not required to be sealed as a vapor barrier. Johns Manville Microlite XG formaldehyde-free Type 75 FSK, Certainteed SoftTouch Type 75 FSK, or equal.
   d. 1” Duct liner: Ducts shown on the drawings to be internally lined with 1” liner are to be lined in the interior with 1 inch thick, 1.5 pounds per cubic foot duct liner with a minimum R-value of 4.2. Duct liner shall be installed in complete accordance with the manufacturer’s installation instructions. Ducts shall be increased in size to accommodate lining without loss of area. Lined ducts need not be covered. Duct liner to be Johns Manville Permacote Linacoustic Standard, Certainteed Type 150 ToughGard R with Enhanced Surface, or equal.
2. Piping:
   a. General: Adhesives and insulation materials: Composite fire and smoke hazard ratings of maximum 25 for Flame Spread and 50 for Smoke Developed. Adhesives to be waterproof.
   b. Refrigerant piping insulation:

1) General: Insulation shall be provided on all suction refrigerant piping on cooling only systems and gas and liquid piping on heat pump systems, including variable refrigerant flow systems.
2) Insulation: Refrigerant piping insulation shall be Armacell AP Armaflex SS or equal 1" wall thickness, elastomeric, closed cell pipe insulation with longitudinal slit and self-sealing adhesive on each side of slit.
3) Refrigerant piping insulation located indoors shall have all elbows covered with PVC jacketing.
4) Refrigerant piping insulation located outdoors is to be sealed with a weatherproof sealant in accordance with the insulation manufacturer's installation instructions. The sealant is to be Armaflex WE finish or equal. All outdoor refrigerant piping is to have PVC jacketing painted for protection from ultraviolet rays.

D. Supports and Anchors:
1. Supports and anchors are to be as shown on the drawings. If supports and anchors are not shown on the drawings the following applies:
a. Hanger rods: Steel, threaded both ends, threaded one end, or continuous threaded.
b. Flashing:
1) Follow the roof manufacturer's recommendations for all roof penetrations, curbs, platforms, and sleepers.
c. Sleeves:
1) Sleeves for round ductwork: Form with galvanized steel.
2) Sleeves for rectangular ductwork: Form with galvanized steel or wood.
3) Stuffing fire stopping insulation: Glass fiber type, noncombustible.
4) Caulk: Acrylic sealant.

E. Vibration isolation:
1. Refer to the Drawings for vibration isolation requirements.
2. Vibration isolation is to be Mason Industries or equal.

F. Mechanical Identification:
1. Piping, duct, valves and damper identification shall be manufactured by Marking Services, Incorporated or equal.
2. Materials:
a. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.
b. Plastic nameplates: Laminated 3-layer plastic with engraved black 2 inch letters on light contrasting background color.
c. Metal tags: Brass aluminum with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
d. Plastic pipe markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.

G. Temperature Controls System:
   1. Install the temperature control systems as described herein and as indicated on the Drawings.
   2. All low voltage wiring (below 120 volt) is to be furnished and installed under this section of the Specifications. Follow manufacturer's type and gauge of wire to meet requirements of field conditions and lengths of run. Install larger transformers as required.
      a. The Contractor shall be responsible for ensuring that all wiring (including the line voltage interlock wiring by the electrical Contractor) is connected so as to provide the sequence of operation required. The Contractor shall provide the necessary information and supervision to the electrical Contractor.
      b. Calibrate all devices, make final settings and test the control system under operating conditions for satisfactory operation with the sequences of operation as shown on the Drawings.
      c. The control systems shall be guaranteed for a period of one (1) year from the date of acceptance against defects in workmanship and materials. Provide any service incidental to the proper performance of the temperature control systems under the guarantee.
      d. The mechanical Contractor may perform all required temperature control functions in lieu of hiring an independent temperature control Contractor, provided the Contractor has the necessary experience and qualified personnel to handle the installation and provide the control adjustments, wiring and start-up/check-out required.

H. Electrical Work:
   1. The following electrical work is required to be provided and installed under Division 16.
      a. Motor starters and disconnect switches for all motors, except where specifically specified, to be furnished by the equipment manufacturer.
      b. Line voltage wiring and conduit to motors, motor starters, and disconnect switches.
      c. Line voltage wiring and conduit to switches as indicated on temperature control diagrams.
      d. Line voltage wiring and conduit for remote control of motors.
      e. Conduit only as required for low voltage temperature control system.
   2. If Contractor furnishes equipment requiring changes in electrical work, it shall be the responsibility of the Contractor to arrange and pay for such changes to result in no additional cost to the Owner.
   3. Contractor shall be responsible for checking electrical Drawings and verifying actual voltage to be supplied before ordering equipment.
   4. Contractor shall provide for the complete installation of wiring and controls required for heating, ventilating, and air conditioning equipment, and shall be responsible for the proper operation of the complete system.

I. Seismic Restraint Systems:
   1. All mechanical system components including, but not limited to, air ducts, piping, air conditioning units, make-up air units and exhaust fans, shall have seismic restraints as required to meet the requirements of Title 24, Chapter 23, of the California State Building Code.

2. Pipes, ducts, and conduits shall be supported and braced per OSHPD anchorage Pre-approved No. OPA-0300 Tolco Seismic Restraint Systems Guidelines. Once the exact location of all pipes and ducts has been established, the structural engineer must check the adequacy of the supporting structure to ensure that the original design is still adequate.
3. All fixed equipment is required to be seismically supported, mounted, and restrained. Supports and anchorage details along with substantiating calculations are required for the following:
   a. Equipment with operating weight over 500 pounds that is mounted directly on the floor or roof.
   b. Equipment with an operating weight over 20 pounds that is suspended from the roof, floor or wall or that is supported by vibration isolation devices.
4. It shall be the Contractor's responsibility to furnish and install <u>all</u> required seismic bracing, supports for all equipment, piping and duct systems required to meet the above-referenced sections of Title 24 of the California Administrative Code. No attempts have been made to identify all of the locations and details of the required supports. The method and details are at the Contractor's option, using the guidelines referred to in Paragraph 2 above.

J. Testing, Adjusting, and Balancing:
1. Scope includes but is not limited to:
   a. Testing, adjustment, and balancing of air systems.
   b. Measurement of final operating condition of HVAC systems.
2. References:
   a. AABC: National standards for field measurement and instrumentation, total system balance.
   b. ASHRAE: Systems handbook: Testing, adjusting, and balancing.
   c. NEBB: Procedural standards for testing, balancing, and adjusting of environmental systems.
3. Submittals:
   a. Submit name of adjusting and balancing agency for approval.
   b. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced Drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
4. Report forms:
   a. Submit reports on AABC National Standards for Total System Balance or NEBB forms.
   b. Forms shall include the following information:
      1) Title page:
         a) Company name
         b) Company address
         c) Company telephone number
         d) Project name
         e) Project location
         f) Project engineer
         g) Project engineer
         h) Project Contractor

i) Project altitude
2) Instrument list data:
a) Instrument
b) Manufacturer
c) Model
d) Serial number
e) Range
f) Calibration date
3) Air moving equipment data:
a) Location
b) Manufacturer
c) Model
d) Air flow, specified and actual
e) Return air flow, specified and actual
f) Outside air flow specified and actual
g) Total static pressure (total external), specified and actual
h) Inlet pressure
i) Discharge pressure
j) Fan RPM
4) Electric motors data:
a) Manufacturer
b) HP/BHP
c) Phase, voltage, amperage; nameplate, actual, no load.
d) RPM
e) Service factor
f) Starter size, rating, heater elements
5) V-belt drive data:
a) Identification/location
b) Required driven RPM
c) Driven sheave, diameter and RPM
d) Belt, size, and quantity
e) Motor sheave, diameter, and RPM
f) Center to center distance, maximum, minimum, and actual
6) Variable refrigerant flow fan coil unit cooling data:
a) Identification
b) Location
c) Service
d) Manufacturer
e) Air flow, design and actual
f) Entering air DB temperature, design and actual
g) Entering air WB temperature, design and actual
h) Leaving air DB temperature, design and actual
i) Leaving air WB temperature, design and actual
j) Air pressure drop, design and actual
7) Variable refrigerant flow fan coil unit heating data:
a) Identification
b) Location
c) Service
d) Manufacturer
e) Air flow, design and actual

f) Entering temperature, design and actual
g) Leaving air temperature, design and actual
h) Air pressure drop, design and actual

8) Exhaust fan data:
a) Location
b) Manufacturer
c) Model
d) Exhaust air flow, specified and actual at minimum and maximum pressure readings
e) Outside air flow, specified and actual for units with intergral economizer
f) Fan RPM

9) Supply fan and cabinet supply fan data:
a) Location
b) Manufacturer
c) Model
d) Air flow, specified and actual
e) Total static pressure (total external), design and actual
f) Actual inlet pressure
g) Actual discharge pressure
h) Fan RPM

5. Air Balance Tolerances:
a. Air balance shall be made with least possible friction.
b. Allowances shall be made for air filter resistance at the time of the tests. The main air supplies shall be at design air quantity with pressure drop across the air filter bank at simulated dirty condition.
c. Air balance tolerances:
1) Supply air: The room air supply shall be plus 10%, minus 0% from the design air quantity for rooms with an air supply of under 1000 cfm and plus or minus 5% where the air supply is 1000 cfm or more. In rooms with multiple supply outlets, the air supplied shall be within plus 5%, minus 0% of the design air quantity.
2) Return air: The main air returns shall be plus 10%, minus 0% from the design air quantity for rooms with an air return of under 1000 cfm and plus or minus 5% where the air return is 1000 cfm or more. In rooms with multiple return inlets, the air returned shall be within plus 5%, minus 0% of the design air quantity.
3) Outside air: The outside air setting is to be plus 5%, minus 5% from the design air quantity.
4) Exhaust air: The exhaust air quantity is to be plus 5%, minus 5% from the design air quantity.

6. Project Record Documents:
a. Comply with Division 1 requirements.

7. Quality assurance:
a. Agency shall be company specializing in the adjusting and balancing of systems specified with a minimum of 3 years experience. Perform work under supervision of AABC Certified Test and Balance Engineer or NEBB Certified Testing, Balancing, and Adjusting Supervisor.
b. Total system balance shall be performed in accordance with AABC National Standards for Field Measurement and Instrumentation, Total

System Balance, ASHRAE Systems Handbook, or NEBB Procedural Standards for Testing, Balancing, and Adjusting of Environmental Systems.

c. Schedule and sequence work to ensure completion of work before substantial completion of Project.

8. Agencies: The following agencies are acceptable for this Project: National Air Balance, Mechanical Environmental Systems (MESA), or equal.

9. Examination:
   a. Before commencing work, verify that systems are complete and operable. Ensure the following:
      1) Equipment is operable and in a safe and normal condition.
      2) Control systems are installed complete and operable.
      3) Proper thermal overload protection is in place for electrical equipment.
      4) Final filters are clean and in place. If required, install temporary media in addition to final filters.
      5) Duct systems are clean of debris.
      6) Correct fan rotation.
      7) Fire/smoke and volume dampers are in place and open.
      8) Coil fins have been cleaned and combed.
      9) Access doors are closed and duct end caps are in place.
      10) Air outlets are installed and connected.
      11) Duct system leakage has been minimized.
      12) Report any defects or deficiencies noted during performance of service to the engineer.
      13) Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.
      14) If, for design reasons, system cannot be properly balanced, report as soon as observed.
      15) Beginning of work means acceptance of existing conditions.

10. Preparation:
    a. Provide instruments required for testing, adjusting, and balancing operations.
    b. Provide additional balancing devices as required.

11. Adjusting:
    a. Recorded data shall represent actually measured or observed condition.
    b. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
    c. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
    d. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
    e. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner's Representative.

12. Air system procedure:
    a. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at all locations.

b. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
c. Measure air quantities at air inlets and outlets.
d. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
e. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
f. Vary total system air quantities by adjustment of fan speeds. Install drive changes as required. Vary branch air quantities by damper regulation.
g. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
h. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
i. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
j. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

PART 3 - EXECUTION

3.1 GENERAL

A. For the actual fabrication, installation and testing of work under this Section, use only thoroughly trained and experienced workmen who are properly qualified for the work they perform. All installers are to be completely familiar with the manufacturer's current recommended methods of installation and shall so execute.

3.2 EQUIPMENT

A. All equipment is to be installed to meet the manufacturer's installation instructions, guidelines, and recommendations.

3.3 SPECIAL REQUIREMENTS

A. During construction meet or exceed all requirements of ASHRAE standard 62.1-2013 Chapter 7, Construction and System Start-up.

B. Provide temporary construction ventilation. Continuously ventilate during installation of materials that emit volatile organic compounds (VOC) and after installation until emissions dissipate including, but not limited to, applications of adhesives, paints, floor coatings, stains and varnishes. Exhaust areas to outside the buildings; do not transfer air to other enclosed spaces. If continuous ventilation is not possible using the building's HVAC system, then ventilate using operable windows and temporary fans that have the capacity to provide a minimum of three (3) air changes per hour in the area requiring ventilation.

C. All fans in the HVAC system are to be turned off and all supply and return openings are to be sealed from dust and debris infiltration during dust producing activities such as drywall installation, sanding, sweeping or blowing, carpet installation, etc.

D. Allow products that have odors and significant VOC emissions to off-gas in dry, well-ventilated space for a sufficient period to dissipate odors and emissions prior to delivery to the construction site. Condition products without containers and packaging to maximize off-gassing of VOCs. Condition products in a ventilated warehouse or other building.

E. Where odorous and/or high VOC-emitting products are applied on-site, apply them prior to installation of porous and fibrous materials including foams.

F. Vacuum carpeted and other accessible surfaces (use a certified vacuum or HEPA vacuum that meets or exceeds the CRI Seal of Approval/Green Label Vacuum Cleaner Program criteria for vacuum cleaning performance) after construction is complete and prior to occupancy.

G. Oil film on sheet metal shall be removed before shipment to site. On-site, inspect ducts to confirm that no oil film is present and remove any oil that is present. If ducts contain dust and dirt, clean them immediately, prior to substantial completion and prior to using the ducts to circulate air. HVAC system components or duct work may only be cleaned, coated, or have applied to its surface disinfectants, pesticides or biocides that are registered and particularly labeled for use in HVAC systems by state and federal EPA.

3.4 REFRIGERANT PIPING INSTALLATION:

A. Total refrigerant piping is to be ASTM B280, Type “ACR” hard-drawn copper.
   1. Mechanical Contractor is to determine exact routing of refrigerant piping in field based on the actual field conditions. The mechanical Contractor is to then coordinate with the equipment manufacturer to determine the refrigerant piping line sizes, location of traps, location and size of suction line accumulators, and any other refrigerant piping accessories.
   2. All elbows are to be long radius elbows.
   3. All joints in refrigerant piping are to be brazed using Silfos-5 or equivalent brazing material. Soft solder is not to be used.
   4. Nitrogen gas is to flow through the piping continuously during brazing operations.
   5. Pressure test system with dry nitrogen to 200 psig using electronic leak detector. Test to no leakage.
   6. Evacuate system and charge completed system with refrigerant after testing. Refrigerant charge is to meet with the manufacturer’s installation instructions.
   7. Horizontal refrigerant piping is to be installed to run level.
   8. All refrigerant suction piping is to be insulated for cooling only systems and both liquid and gas piping is to be insulated for heat pump systems, including variable refrigerant flow systems.

3.5 DUCT AND ACCESSORIES

A. Installation:

1. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
2. Connect terminal units to main supply air with galvanized steel duct.
3. Connect diffusers to low pressure ducts in concealed locations with 5 feet maximum length of flexible duct. Hold in place with strap or clamp to prevent duct from collapsing above diffuser.
4. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.
5. Provide balancing dampers on medium pressure systems where indicated.
6. Provide fire/smoke dampers at locations indicated. Install with required perimeter mounting angles, sleeves, breakaway duct connection, corrosion resistant springs, bearings, bushings, and hinges.
7. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
8. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire/smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated.
9. Provide duct test holes where indicated and required for testing and balancing purposes.
10. Check location of outlets and inlets and make necessary adjustments in position to conform with Architectural features, symmetry, and lighting arrangement.
11. Install diffusers to ductwork with airtight connection.
12. Paint ductwork visible behind air outlets and inlets matte black.

3.6 MECHANICAL SYSTEM AND EQUIPMENT INSULATION

A. Install all insulation, including duct liner, in strict accordance with the manufacturer's installation instructions and Specifications.

B. Ductwork:
1. Do not install covering before ductwork and equipment has been tested, and accepted by the tenant's representative.
2. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.
3. Ensure insulation in continuous through inside walls. Pack around ducts with fireproof, self-supporting insulation material, properly sealed.
4. Finish insulation neatly at hangers, supports, and other protrusions.
5. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

C. Refrigerant Piping Insulation:
1. General: Insulation shall be provided on all suction refrigerant piping on cooling only systems and gas and liquid piping on heat pump systems, including variable refrigerant flow systems. Insulation is to be installed in complete accordance with the manufacturer's installation instructions.
2. Refrigerant piping insulation installed indoors shall have PVC jacketing on all elbows.
3. Refrigerant piping insulation located outdoors is to be sealed with a weatherproof sealant in accordance with the insulation manufacturer's installation instructions.

All outdoor refrigerant piping is to have PVC jacketing painted for protection for ultraviolet rays.

3.7 MECHANICAL IDENTIFICATION

A. Installation:
1. Degrease and clean surfaces to receive adhesive for identification materials.
2. Plastic nameplates: Install with corrosive-resistant mechanical fasteners or adhesive.
3. Plastic or metal tags: Install with corrosive-resistant chain.
4. Plastic pipe markers: Install in accordance with manufacturer's instructions.
5. Equipment: Identify all equipment with plastic nameplates. Small devices may be identified with plastic metal tags.
6. Controls: Identify control panels and major control components' outside panels with plastic nameplates.
7. Valves: Identify valves in main and branch piping with tags.
8. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. In-stall in clear view and align with axis of piping. Location of identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.
9. Balancing Dampers: Identify all balancing dampers in concealed areas with fluorescent colored plastic flagging tape, min. 1-3/16" wide. Tape to be long enough so that it can be seen from the access location.
10. Provide valve chart and schedule in aluminum frame with clear plastic shield. In-stall at location as directed.

3.8 SUPPORTS AND ANCHORS

A. Fabrication:
1. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
2. Design hangers without disengagement of supported pipe.
3. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

B. Equipment bases and supports:
1. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Flashing:
1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, and roofs in accordance with roofing manufacturer's recommendations.
2. Provide acoustical lead flashing around ducts and pipes penetrating building wall from roof-mounted equipment. Flashing to be installed in accordance with manufacturer's instructions for sound control.

D. Sleeves:
   1. Where piping or ductwork penetrates ceiling or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk seal airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
   2. Install steel escutcheons at finished surfaces.

3.9 SYSTEM TEST AND STARTUP

A. Check the installation and connection requirements for conformance with the manufacturer's installation instructions for each piece of equipment. Perform the step-by-step checkout and startup procedures for each piece of equipment in accordance with the manufacturer's startup instructions.

B. The mechanical Contractor is to coordinate the efforts of the Test and Balance Contractor to ensure that all systems are tested and performing as intended.

C. Make all necessary control and system adjustments and operate the system in its final configuration for a period of ten (10) working days for the purpose of proving satisfactory performance. During this period, instruct such persons as Owner may designate in proper operation, care, and maintenance of the systems.

3.10 ACCEPTANCE REQUIREMENTS

A. The Contractor shall be responsible for the completion of all acceptance requirements in the 2013 California Building Energy Efficiency Standards (Title 24).

B. Refer to Section 23 05 00 - Acceptance Requirements for additional information on acceptance requirements.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions, Supplementary Conditions, and Division 01 General Requirements apply to the work specified in this Section.

1.2 SUMMARY

A. Section Includes: The work shall consist of furnishing all labor, materials, and equipment required, including the cost and coordination necessary to engage a certified HERS rater if duct leakage testing is required, to complete the Building Envelope and the Mechanical Acceptance Requirements of the California Building Energy Efficiency Standards (2013) and submit the required forms. Work shall include, but not be limited to, the following principal items:
1. Visual inspection of the equipment and installation.
2. Review of the certification requirements.
3. Functional tests of the systems and controls.
4. Completion of the required forms and submission to the authority having jurisdiction.

1.3 RELATED WORK

A. Glazing.

B. Entrances and Store Fronts.

C. Aluminum Windows.

D. Heating, Ventilating and Air Conditioning Systems, Section 23 00 00.

E. Electrical, Division 26.

F. Plumbing Systems, Section 22 00 00.

1.4 GENERAL REQUIREMENTS

A. All labor, material and testing apparatus required to complete the Acceptance Testing of the Building Envelope and the Heating, Ventilating and Air Conditioning (HVAC) systems to meet the 2013 Title 24 Acceptance Requirements are to be included as a part of this work. For additional information on the 2013 Title 24 testing acceptance requirements refer to www.energy.ca.gov\title24\2013 standards\.

B. Verification of Conditions: Prior to beginning Acceptance Testing of the mechanical equipment, inspect all equipment and verify that equipment is properly installed and ready for operation.

C. Codes: Work must comply with the Applicable Code Requirements.

D. Reference Standards: Published specifications, standards, tests, or recommended methods of trade, industry, or governmental organizations apply to work of this Section where cited below:
   1. Air Moving and Conditioning Association (AMCA).
   2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
   3. American Society of Mechanical Engineers (ASME).
   4. American Society of Plumbing Engineers (ASPE).
   5. Associated Air Balance Council (AABC).
   6. National Electrical Manufacturers Association (NEMA).
   7. National Fire Protection Association (NFPA).
   8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
   9. California Building Code (CBC).
   10. State of California - OSHA.
   11. California Mechanical Code (CMC).
   12. The State of California Codes and Safety Orders.
   13. 2013 California Building Energy Efficiency Standards (Title 24).
   14. State Fire Marshal requirements (SFM).
   15. Air Conditioning and Refrigeration Institute (ARI).
   16. State of California Environmental Quality Act.
   17. American Society of Testing and Materials (ASTM).
   18. Underwriters Laboratories (UL).
   19. Occupational Safety and Health Act (OSHA).
   20. National Bureau of Standards (NBS).
   21. American National Standards Institute (ANSI).
   22. AMCA Standard 99: Standards Handbook
   23. AMCA/ANSI Standard 204: Balance Quality and Vibration Levels for Fans
   24. AMCA Standard 210: Laboratory Methods of Testing Fans for Ratings
   25. AMCA Standard 300: Reverberant Room Method for Sound Testing of Fans
   26. AMCA Standard 500:Test Methods for Louvers, Dampers and Shutters
   27. ARI Standard 410: Forced-Circulation Air-Cooling and Air-Heating Coil
   28. ANSI/ASHRAE 15: Safety Code for Mechanical Refrigeration
   29. ASHRAE Standard 52: Gravimetric and Dust Spot Procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
   30. ASHRAE/ANSI Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems
   31. ASME Section VIII: Unified Pressure Vessel Code
   32. UL Standard 1995: Heating and Cooling Equipment
   33. ASTM A-525: Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   34. ASHRAE Standard 62.1-2013: Ventilation for Acceptable Indoor Air Quality.
   35. ANSI/ASHRAE Standard 55-2013: Thermal Environmental Conditions for Human Occupancy.

1.5 ROLES AND RESPONSIBILITIES

A. Acceptance testing, the completion of the Certificate of Acceptance forms and the submittal of the Certificate of Acceptance forms to the authority having jurisdiction are the responsibility of the installing Contractor. The responsible Contractors for the building envelope acceptance test for fenestration and mechanical acceptance test requirements are as follows:

1. Building envelope acceptance test for fenestration: This acceptance test and completion of the Certificate of Acceptance form is to be completed by the fenestration installing Contractor.
2. Mechanical acceptance requirements: The mechanical acceptance test requirements and completion of the required Certificate of Acceptance forms are to be completed by the HVAC system installing Contractor.

B. Individual acceptance tests may be performed by one or more Field Technicians under the responsible charge of the installing licensed Contractor (Responsible Person) eligible under Division 3 of the Business and Professions Code, in the applicable classification, to accept responsibility for the scope of work specified by the Certificate of Acceptance document. The Responsible Person must review the information on the Certificate of Acceptance form and sign the form to certify compliance with the acceptance requirements. The individuals who perform the field testing/verification work and provide the information required for completion of acceptance form (Field Technicians) are not required to be licensed Contractors. Only the Responsible Person who signs the Certificate of Acceptance form to certify compliance must be licensed.

C. Field Technician: The Field Technician is responsible for performing and documenting the results of the acceptance procedures on the Certificate of Acceptance forms. The Field Technician must sign the Certificate of Acceptance to certify that the information he provides on the Certificate of Acceptance is true and correct. It is important to note that the Field Technician is not required to have a Contractor's license. A license is only required of the Responsible Person described below.

D. Responsible Person: Each certificate of Acceptance must be signed by a licensed Responsible Person who is eligible under Division 3 of the Business and Professions code in the applicable classification, to take responsibility for the scope of work specified by the Certificate of Acceptance document. The Responsible Person can also perform the field testing and verification work, and if this is the case, the Responsible Person must complete and sign both the Field Technician's signature block and the Responsible Person's signature block on the Certificate of Acceptance form. The Responsible Person assumes responsibility of the acceptance testing work performed by his Field Technician agent or employee.

E. The acceptance requirements process must address the following:
1. Review the bid documents to make sure that sensor locations, devices and control sequences are properly documented.
2. Review of the installation, and complete the required acceptance testing.
3. Certify the acceptance test results on the Certificate of Acceptance, and submit the certificate to the enforcement agency prior to receiving a final occupancy permit.

1.6 SUBMITTALS

A. At the completion of the acceptance testing and Certificate of Acceptance forms, the fenestration installing Contractor and the HVAC system installing Contractor are to submit their respective Certificate of Acceptance forms to the authority having jurisdiction with a copy to the Architect.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. The Acceptance Agent is to provide the test equipment and the test materials required for performing the required acceptance testing.

2.2 FORMS AND PROCEDURES

A. Refer to the 2013 Non-Residential Compliance Manual for the 2013 Building Energy Efficiency Standard for the complete list of acceptance tests and related Certificate of Acceptance forms that may be required.

B. The actual acceptance tests required are shown on the Title 24 forms provided on the drawings.

PART 3 - EXECUTION

3.1 ACCEPTANCE TESTING PROCESS

A. Overview:
1. The acceptance requirements require the following four (4) major check-points to be conducted by the installing Contractor:
   a. Plan review
   b. Construction inspection
   c. Functional testing and verification
   d. Certificate of Occupancy
2. Each of these four (4) major check-points are described in more detail below:

B. Plan Review:
1. The installing Contractor responsible for certification of the acceptance testing/verification on the Certificate of Acceptance (Responsible Person) must review the plans and specifications to ensure that they conform to the acceptance requirements. This is typically done prior to signing a Certificate of Compliance.
2. The Title 24 documents will include code compliance forms which list the respective envelope and mechanical systems that will require acceptance tests, and the parties responsible for performing the tests.

C. Construction Inspection:
1. The installing Contractor responsible for certification of the acceptance testing/verification on the Certificate of Acceptance (Responsible Person) must perform a construction inspection prior to testing.
2. The purpose of the construction inspection is to assure that the equipment that is installed is capable of complying with the requirements of the Standards. Construction inspection also assures that the equipment is installed correctly and is calibrated.

D. Functional Testing:
1. A Field Technician must take responsibility for performing the required acceptance requirements procedures. All of the required acceptance tests for a project need not to be performed, the Field Technician who performs the test is responsible for identifying all performance deficiencies, ensuring that they are corrected, and if necessary, he must repeat the acceptance requirement procedures until the specified systems and equipment are performing in accordance with the acceptance requirements. The Field Technician who performs the testing must sign the

Certificate of Acceptance to certify the information he has provided to document the results of the acceptance procedures is true and correct.

2. A licensed Contractor, who is eligible under Division 3 of the Business and Professions Code in the applicable classification, to take responsibility for the scope of work specified by the Certificate of Acceptance must review the test results from the acceptance requirement procedures provided by the Field Technician and sign the Certificate of Acceptance to certify compliance with the acceptance requirements. Regardless of who performs the tests, a Responsible Person must review the forms and sign off on them. The Responsible Person may also perform the Field Technician's responsibilities, and must then also sign the Field Technician declaration on the Certificate of Acceptance to certify that the information on the form is true and correct.

3.2 COMPLETION OF ACCEPTANCE TESTING

A. The Acceptance Testing work will be complete when the fenestration Contractor and the HVAC system installing Contractor have completed the required acceptance tests and have completed the acceptance testing forms and completed and signed the Certificates of Acceptance for their respective installation and submitted this documentation to the authority having jurisdiction and to the Architect.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

A. Objective: It is the objective of this specification to provide for the avoidance of excessive noise or vibration in the building due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit.

B. Description of Work: Furnish, install, assemble, set up, test (hereinafter "provide") the following systems and equipment in accordance with the Contract Documents.
1. Isolation of mechanical equipment including but not limited to fans, package air conditioning units, refrigeration compressors, cooling towers, evaporative condensers and pumps, including bases.
2. Isolation for ductwork and piping (including but not limited to domestic hot and cold water, waster, soil, vent and including all piping connected to vibrating equipment).
3. Seismic restraints for all vibration isolated and non-vibration isolated equipment, piping, ductwork and in-line devices.
4. Supervision and inspection of installation of vibration isolation to equipment.
5. Provision of all Motion Restraints required by applicable codes for noise and vibration control equipment/systems specified herein.
6. Coordination of Airtight Installation requirements at Mechanical Rooms and/or Drywall Duct Enclosures.

1.2 Related Work in Other Sections:

A. Concrete, Division 03

B. Thermal and Moisture Protection, Division 07

C. Finishes, Division 09

D. Plumbing, Division 22

E. Heating, Ventilating, and Air-Conditioning, Division 23

F. Electrical, Division 26

1.3 Reference Standards:

A. Standards: Provide equipment and installation in accordance with the latest edition and revisions of all applicable standards and specifications of all appropriate agencies including, but not limited to, the following:

1. American Institute of Steel Construction (AISC) publications:
   a. Specification for the Design, Fabrication and Erection of Structural Steel Buildings (13th Edition).
2. American National Standards Institute (ANSI) Standard
a. B027.2-965 – Plan Washers.
3. ARI - Air Conditioning and Refrigeration Institute
   a. ARI 260 - 2012 Standard for Sound Rating of Ducted Air Moving and Conditioning Equipment.
   b. ARI 270 - 1995 Standard for Sound Rating of Outdoor Unitary Equipment.
   c. ARI 275 - 1997 Standard for Application of Sound Rating Levels of Outdoor Unitary Equipment.
   d. ARI 280 - 1995 Standard for Requirements for the Qualification of Reverberant Rooms in the 63 Hz Octave Band.
   e. ARI 300 - 2000 Standard for Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment.
   f. ARI 350 - 2000 Standard for Sound Rating of Non-Ducted Indoor Air-conditioning Equipment.
   g. ARI 370 - 2001 Standard for Sound Rating of Large Outdoor Refrigerating and Air-conditioning Equipment.
   h. ARI 530 - 1995 Standard for Method of Rating Sound and Vibration of Refrigerant Compressors.
   i. ARI 575 - 1994 Standard for Method of Measuring Machinery Sound Within an Equipment Space.
   j. ARI 885 - 1998 (Add 2002) Standard for Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
4. ASTM - American Society for Testing and Materials
   a. Specification A123/A123M-09 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. Test Method ASTM D471-10 Standard Test Method for Rubber Property-Effect of Liquids.
   c. Test Method ASTM D2240-05(2010) Standard Test Method for Rubber Property- Durometer Hardness.
   d. Test Method ASTM E84-11a Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. Specification A6/A6M-11 Standard Specification for General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling.
   f. Specification A36/A36M-08 Standard Specification for Carbon Structural Steel.
   g. Specification A53/A53M-10 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   h. Specification B663-94(2006) Standard Specification for Silver-Tungsten Carbide Electrical Contact Material.
   i. Specification A307-10 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

j. Specification A500/A500M-10a Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
k. Specification A501-07 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
l. Specification A1011/A1011M-10 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength, Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

5. ASA - Acoustical Society of America/ANSI
   a. ANSI S12.2-2008 American National Standard Criteria for Evaluating Room Noise.
   b. ANSI S12.11-2003 (R2008) American National Standard Method for the Measurement of Noise Emitted by Small Air-Moving Devices.
   c. ANSI S12.18-1994 (R2009) American National Standard Procedures for Outdoor Measurement of Sound Pressure Level.
   d. ANSI S12.30-1990 (R2002) American National Standard Guidelines for the Use of Sound Power Standards and for the Preparation of Noise Test Codes.
   e. ANSI S12.31-1990 (R2001) American National Standard Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reverberation Rooms.
   f. ANSI S12.36-1990 (R1997) American National Standard Survey Methods for the Determination of Sound Power Levels of Noise Sources.
   g. ANSI S12.54-2011 / ISO 3744:2010 Acoustics - Determination of Sound Power Levels and Sound Energy Levels of Noise Sources Using Sound Pressure - Engineering Methods for an Essentially Free Field over a Reflecting Plane.
6. AMCA - Air Movement and Control Association International, Inc.
   a. AMCA Standard 300-08, Reverberant Room Method for Sound Testing of Fans.
   b. AMCA Standard 320-08, Laboratory Methods of Sound Testing Fans Using Sound Intensity.
   c. ANSI/AMCA Standard 330-97 (ANSI/ASHRAE 68-99), Laboratory Method of Testing to Determine the Sound Power in a Duct .
7. AWS - American Welding Society, Inc.
   a. AWS D1.1 - 2010 Structural Welding Code – Steel.
8. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers
   a. 2007 HVAC Applications Manual, Chapter 47.
9. CTI - Cooling Technology Institute
   a. CTI ATC-128, Test Code for Measurement of Sound From Water-Cooling Towers
10. SMACNA - Sheet Metal & Air Conditioning Contractor's National Association, Inc.

a. Rectangular Industrial Duct Construction Standards, 2nd edition, 2004.
b. Round Industrial Duct Construction Standards, 3rd edition, 1999.
c. HVAC Duct Construction Standards - Metal & Flexible, 3rd edition, 2005.
d. Architectural Sheet Metal Manual, 6th edition, 2003.
e. Seismic Restraint Manual: Guidelines for Mechanical Systems, 2nd edition, 2008.

1.4 Quality Assurance

A. Codes: Perform installation in accordance with all applicable international, federal, state, county, municipal and local codes and regulations.

B. Conflicts: Present any conflicts between codes, regulations, specifications and/or requirements at least thirty (30) days prior to the commencement of the scheduled work.

C. Related Provisions: Division 01 – General Provisions, Division 23 – Heating, Ventilating, and Air-Conditioning: Apply to the work of this Section.

D. Schedules: See contents of this Section for specific specifications and schedules of vibration isolators, frames and static deflections.

E. Product Suppliers: All vibration isolation devices, equipment bases and frames for equipment and piping furnished under Division 23 shall be designed and furnished by no more than two different isolator manufacturers and no single vibrating element shall be isolated by the products of more than one isolator manufacturer.

F. Supervision: The installation of all vibration isolation units, and associated hangers and bases shall be under the direct supervision of the vibration isolation manufacturer's representative.

1.5 Coordination

A. Coordinate with Finish Systems, Piping Systems and Equipment, Water Cooling and Heating, Plumbing Systems, Heating, Ventilating and Air Conditioning and Electrical sections for installation of vibration isolation. Coordinate with Concrete trade for equipment inertia bases. Coordinate Work of this Section with all other impacted trades.

1.6 Unit Noise Levels

A. The following are the maximum sound power levels acceptable for HVAC equipment delivered for this Project. Coordinate these requirements with other Division 23 Equipment submittals.

B. Submit manufacturer data obtained in an AMCA or NVLAP approved acoustical testing facility for the submitted unit tested at the static pressures and CFM's proposed for this Project.
   1. Test to be conducted according to the relevant laboratory standards for equipment submitted, using the appropriate procedures listed in 1.3 Reference Standards above.
      a. Exception: Manufacturers may extrapolate data from other similar units operating at brake horsepower and CFM within 20% of the values scheduled for this Project.
   2. Maximum HVAC Equipment Sound Power Levels
      a. Combined HVAC equipment casing radiated, inlet and discharge sound power levels (PWL), in dB re. 10-12 watts shall not be more than the following levels:

Item	PWL (dB)						
							Octave Center Band (Hz)
	125	250	500	1000	2000	4000	8000

      b. The following variances will be accepted for equipment otherwise satisfying the maximum noise criteria above:
         1) 2 dB variance in each of not more than 4 octave bands.
         2) 4 dB variance in a single octave band.

1.7 Submittals

A. Refer to Division 01 for procedures.

B. Descriptive Data - Submit the following:
   1. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications and schedules herein. Include load versus deflection curves.
   2. An itemized list showing the items of equipment, piping, etc., to be isolated, the isolator type and model number selected, isolator loading and deflection, wire diameter and number of coils in springs, and references to specific shop drawings showing frame construction where specified.
   3. Written approval of the frame design to be used, obtained from the equipment manufacturer.

4. Written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices, including hangers and bases; alternatively the equipment may be installed by the vibration isolation manufacturer.
5. For each Motion Restraint to be provided on this project which is neither already fully detailed in the plan nor an OSHPD pre-approved spring/frame support, the contractor shall submit a stress analysis prepared by California licensed Civil or Structural Engineer.
   a. Provide sufficient detail to permit architect and authorities having jurisdiction to verify compliance with all applicable Codes and these specifications.
   b. For vibration isolation used with base mounted equipment over 300 pounds or suspended equipment over 20 pounds, provide calculations for:
      1) Shear,
      2) Pull-up,
      3) primary overturning and
      4) secondary overturning.
   c. For isolator and frame systems that have a current OSHPD approval for installation under identical conditions to those on this project. The contractor may submit OSHPD pre-approved detail in lieu of a project specific calculation requiring under the proceeding paragraphs.
6. An itemized list of all items of equipment to be fitted with flexible piping and/or duct connections.
   a. Flexible piping and/or duct submittals shall contain all information and calculations to demonstrate conformance and suitability for the equipment operating conditions including but not limited to pressure, temperature, capacity, mounting, maintenance, etc.
   b. Submittals shall also include independent acoustical test data demonstrating at least 20 dB attenuation of vibration accelerations at typical blade passage frequencies.
7. A schedule of airtight and resilient sleeves which will be used where ducts, pipes and/or conduit penetrate building construction, including where necessary in order to maintain airtight mechanical rooms.
8. Manufacturer's sound trap construction details, certified test results for both dynamic insertion loss (forward and reverse flow) and self noise; and a complete description of test conditions and measurement procedure in strict compliance with the requirements of this section.
9. Catalog cuts for acoustical duct lining, duct lagging and plenum lining.
10. Certified acoustic test data for terminal units. Provide maximum casing radiated and discharge noise PWL and SPL in accordance with the specified procedures. Provide acoustical test data for in duct insertion loss.

C. Shop Drawings - Submit the following and secure approvals prior to fabrication:

1. Drawings showing equipment frame construction for each machine, including dimensions, structural member sizes, support point locations, etc.
2. Drawings showing methods for suspensions, support, guides, etc., for piping and ductwork, etc.
3. Drawings showing methods, for isolation of ducts, pipes, etc., piercing walls, slabs, beams, etc.
4. Drawing showing methods numbers and details of Motion Restraints and anchors for equipment, frames, isolators, piping, ductwork, etc., including calculations as above.
    a. Where Contractor-proposed substitutions change the weight, size, configuration or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, the Contractor shall submit calculations for proposed anchors and supports, and install them as shown in these calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
    b. Where Contractor-proposed substitutions are claimed to have no effect on anchors and supports detailed on the Contractor Documents, Contractor shall submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
    c. Contractor shall submit details and calculations for all embedded inserts, drilled inserts and other fasteners for attachments of suspended components showing the load-carrying capacity of each device calculated in accordance with Chapter 16 of the California Building Code. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
    d. For all anchorages and supports not detailed on the Contract Documents, Contractor shall submit details and calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
5. Details for concrete and steel bases including anchor bolt locations.
6. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, showing compliance with California Building Code and coordination with the Project Architectural, Structural and Mechanical Documents.
7. Details of flexible piping and duct connections for all typical conditions listed in the schedule provided above.

PART 2 - PRODUCTS

2.1 General Properties

A. Deflection: Vibration isolators shall have either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

B. Range: Isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer and must be linear over a deflection range 60% above the design deflection.

C. Ratio: Ratio of lateral to vertical stiffness shall not be less than 1.0 or greater than 1.3.

D. Nested: Unless specifically noted, nested spring designs shall not be permitted.

E. Uniformity: Vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ by more than 10%.

F. Isolation: Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems within 10% up to 50 dB or greater at all frequencies above 150 Hz.

G. Protection: Isolators installed outdoors shall be designed for such exposure suitable to the Project conditions.
   1. Springs shall be coated in neoprene or PVC, or shall be hot dip galvanized.
   2. All neoprene mountings shall have a Shore-A hardness of 30 to 50, after minimum aging of 20 days or corresponding oven-aging.

H. Internal Isolation: Where vibration isolators and associated equipment frames have been specified herein for "package" air-handling units which are available with "internal" isolation; the contractor shall comply with the following:
   1. Provide neoprene mounts for the "internal" isolation supplied by the air-handling unit manufacturer. Such mounts shall be of 30 to 60 durometer neoprene and shall have a static deflection no greater than 0.25 times the static deflections of the external isolators scheduled in 2.6.
   2. "Internal" isolation in lieu of the specified external vibration isolators and equipment frames scheduled in 2.6 is unacceptable.

2.2 Isolator Description

A. Application Cross-Reference: For application and the specific static deflection requirements of the isolators described below, refer to schedules and references elsewhere herein.

1. Type MS & MSSR: Bare spring type equipped with leveling bolts and with two layers of ribbed or waffled neoprene pad separated by a 1/16" galvanized steel plate under the base plate. Type MSSR shall be fabricated with integral steel housing, with inspection ports, providing all directional motion restraint.
2. Type MSL: Bare spring type with two layers of ribbed neoprene pad with 1/16" galvanized steel separator between layers under the base plate. Provide limit stops to prohibit spring extension if the load is removed. These stops shall serve as rigid blocking during erections so that the installed and operating heights shall be the same. Provide a minimum of 1/2" clearance around restraining bolts and between the limit stops and the housing so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation.
3. Type HS: Suspension hangers having a steel frame and spring element in series with a 1” thick neoprene pad with integral grommet. The design static deflection under load shall be as shown on the schedule. The isolator shall be designed so hanger rod may be misaligned 15 degrees relative to the vertical without touching integral grommet inset in hanger box frame.
4. Type HD: Spring hangers, load transfer. Same as Type HS with washer and nut assembly and indicator for load transfer and deflection readout.
5. Type HN: Suspension hangers having a neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5" designed to preclude contact of hanger rods with frame at up to 15 degrees misalignment.
6. Type MN: Neoprene isolator unit having a minimum static deflection range of 0.25" to 0.5".
7. Type NSP: Neoprene pad. Waffled or ribbed. Typically 5/16” to 1/2" thick. Durometer of 50 maximum. Static deflection typically 0.05". Nominal design 40 durometer for 0.05" static deflection under 60 psi load. Provide steel load distribution plates. Size of pad to be selected by isolator supplier based on load per point.
8. Type MND: Neoprene Mount, Deep Displacement. A machinery mount with a neoprene diagonal lattice structure located between steel base and a support plates. Suitable for loads from 300 to 4000 lbs and for driving frequencies as low as 6 Hz. Capable of providing static deflections from 5/8" to 1" with lateral stability.

2.3 Equipment Frames

A. General Properties: Mounting frames and/or brackets shall be provided to carry the load of the equipment without stressing or causing mechanical distortion of the equipment. Each piece of equipment shall be supported at least four points by vibration isolators and restrained at least four locations by Motion Restraint.
   1. Rigid Steel (RS): Construction:
      a. Rectangular with a minimum of four pieces of welded, wide flange structural steel with welded height saving brackets to accept the isolators. Additional frame members shall be provided as necessary to support pumps, motors, etc.

b. The section depth of the frame members shall be greater than 1/10 of the length of the longest frame member, and shall be constant in all four perimeter frame pieces.

2. Concrete Inertia Bases (CI): Construction:
   a. Welded structural forms with 1/2" (minimum) steel reinforcing bars welded in place on at least 6" centers running in both directions. The bottom edge of the steel bars shall be 1-1/2" from the bottom of the base. Drilled steel members with sleeves welded below the holes to receive anchor bolts.
   b. Provide height saving brackets at all mounting locations.
   c. Except where otherwise noted, the base weight shall be at least equal to the weight of the mounted equipment. Concrete shall be not less than 3" in thickness. Provide a minimum clearance of 2" between the concrete base and the floor slab or housekeeping pad.
3. Type BR: Brackets to equipment. Height saving brackets attached directly to equipment where rigidity of same does not require supplemental frame.
4. Type TS: Trapeze. Used to distribute load or to conserve space. Supporting sling of steel members with mount or hangers at each end. The section depth of the frame members shall be greater than 1/10 the depth of the longest frame member.
5. Type RPA: Rail Pair Assembly Construction:
   a. Paired mounting rails along the longest base dimension of the equipment to be isolated.
   b. Provide isolation by bare springs mounted on 1/4" thick neoprene cups at the bottom and under a threaded metal cap at the top. A height adjustment bolt shall attach the metal cap to the upper angle iron rail. The size and spacing of the springs shall be selected by the vibration isolation manufacturer so as to accommodate the equipment's center of gravity and provide a level installation.
      1) Vertical height restraint bolts, similar to those provided with Type MSL spring mounts, are not acceptable in lieu of independent Motion Restraint specified below.
      2) Refer to Part 3 for special execution instructions for RPA.
6. Integrated Roof-mounted Spring and Frame (IRSF): The integrated roof-mounted spring and frame assembly shall consist of a rectangular angle iron equipment frame supported by a type MS isolator on a steel channel roof perimeter. This assembly integrates with the roof insulation and canting to provide a weather-tight seal with cover plates removable for isolator inspection. The IRSF shall provide integral motion restraint and shall be available in stock modular construction components.

2.4 Equivalent Vibration Isolation and Equipment Frames

A. Isolators
   1. Acceptable subject to 2.2 above:

Type	Description	Mason Industries	Vibrex/ Saussé	Lord Mechanical Products	Kinetics	Amber Booth	Vibration Mounting & Controls
MS	Spring Mount	SLF*	RMSG*	--	FDS*	SW*	ADC*
MSSR	Spring Mount - Housed	SSLFH	RMSP-EQ	--	--	--	AEQ
MSL	Spring Mount with Limit Stop	SLR C series	RMLS-EQ	--	FLS	CT	AWR
	Under 1.5" S.D. and under 200 pounds load per isol.	SLR A series	RMUJ-EQ-SH	--	FLS	CT	AWR
HS	Spring Hanger	30*	HXA*	--	SRH*	BSRA*	SH*
HD	Spring Hanger	PC30N*	--	--	--	--	
HN	Neoprene Hanger	HD*	HSS*	--	RH*	HRD*	RHD*
MN	Neoprene Mount	ND*	FU*	--	RD*	RVD*	RD*
MND	Neoprene Mount, Deep Deflection*	--	--	Lattice Mount	--	--	--
NSP	Neoprene	W, WM*	R*		NPS*	SP-NR*	Shear-flex

*Unrestrained isolation systems require separate Motion Restraint as specified below.

B. Frames and Curbs
1. Acceptable subject to 2.3 above:

Type	Description	Mason Industries	Vibrex/ Saussé	Kinetics	Amber Booth	Vibration Mountings & Controls
RS	Rigid Steel	MSL/WFSL	RMSB	SFB	--	WFB-AC
CI	Concrete Inertia Base	KSL	RMSB-I	CIB	--	WPF-AC
RPA	Spring Rail w/ Independent Snubber	ASSR*	RMR-3200	--	--	--
IRSF	Integrated Roof/Spring Mount	ISC or RSC	VIC-EQ or VibroCURBII	ESR	--	--

2.5 Motion Restraints

A. Objective: Provide motion restraining devices at all vibration isolated piping and equipment. Design restraints to comply with applicable Code in Project Jurisdiction.

B. General properties:
1. Restraints shall permit adjustment during installation to insure sufficient clearance between vibration isolated element and rigid restraining device.

2. Restraints at base supported equipment shall include resilient neoprene pads at all potential contact areas between isolated equipment and rigid restraining element.
3. Restraints shall be selected to be capable of providing the after installation adjustment and clearance tolerances required under Part 3 of this Section.

C. Restraint Description
1. Restraining devices at base supported vibration isolated equipment shall be as manufactured by Mason Industries, type Z-1011 or equal by Vibrex/Saussé, Amber Booth or Kinetics.
2. Coordinate restraint bolt locations with the structural and mechanical drawings and conditions.
3. Restraints at suspended piping and equipment shall consist of stainless steel cables together with neoprene snubbers arranged to achieve the required all-directional restraint and sized to resist the forces defined. Shop Drawings shall indicate proposed method for achieving vertical restraint for ceiling suspended piping. Cables shall have sufficient slack to avoid short circuiting the vibration isolators.

2.6 Vibration Isolator Application and Schedules - Equipment

A. General: The isolator type scheduled shall be furnished and installed for the following mechanical equipment in accordance with Part 3 herein, loaded to yield the specified deflection per the schedule below at each isolator. The contractor shall verify that the dead load deflection of the structure at each isolator location is less than 0.25 times the isolator static deflections scheduled herein. In the event that the dead load deflection of the structure at any isolator location is greater than 0.25 times the scheduled isolator static deflection, the contractor shall increase the static deflection of such isolators to be at least 4.0 times the dead load deflection of the structure.

B. Application Schedule:

Equipment Designation	Isolation Type	Frame Type	Minimum Static Deflection (inches)	Mounting Notes
CSF-1	HS		0.75	
EF 1, 2 & 3	MS		0.75	
VFC's 2-1 through 2-5, 3-1, 3-2, 3-3	NSP		.20	

VFC's 1-5, 1-9, 1-12, 1-14 and 1-18	HS	0.75	

2.7 Piping Resilient Support and Suspension

A. Execution Cross-Reference: Refer elsewhere in this Section for the requirements of Resilient Penetrations and Flexible Connections. Refer to Part 3 for the extent of the resilient piping support cited below.
   1. At horizontal suspended pipe 2" and smaller connected to vibrating equipment over 1/2 HP provide Type HS isolator or floor supported Type MSL isolator with a minimum 1.0" static deflection. At horizontal suspended piping larger than 2" provide type HD isolator or floor supported Type MSL isolator with a minimum of 1-1/2" static deflection.
   2. At vertical riser pipe supports supporting piping attached to vibrating equipment over 1/2 hp over 1.0" O.D., provide Type MS isolators selected for a minimum static deflection of 1.0".
   3. At pipe anchors for piping attached to vibrating equipment provide Types MN or HN to avoid direct contact of piping with building.
   4. Pipe sway braces where required and attached to vibrating equipment shall utilize neoprene elements of 40 durometer maximum and of 3/8" minimum thickness, Type MN shall be used where such braces are required to accommodate both tension and compression forces.

B. High Velocity Ductwork: At ducts with air velocities greater than 1600 FPM provide Type MSL if roof/floor supported, or Type HS if suspended up to 50 ft from the unit. Minimum static deflection for high velocity ductwork isolators is 1 inch. Penetrations of shaft assemblies by such ductwork shall be non-rigid as described elsewhere in this Section.

C. Vaneaxial Fans: At vaneaxial fans operating against a static of 3" w.g. or greater provide neoprene/spring thrust snubbers, type WBI or WBD by Mason or equal by Vibrex/Saussé.

2.8 Flexible Duct Connections

A. Application: Provide flexible duct connections between duct and vibrating equipment to avoid the occurrence of rigid connections.

B. Fabric: Flexible connection fabric shall be a non-combustible water-proof, airtight, glass fabric, one side coated with Neoprene, weight 20 ounce per square yard. For ducts operating at over 100°F and for acid resistant applications, flexible fabric shall be 30 ounce neoprene coated glass fabric. All fabric shall meet the applicable Code of the project jurisdiction.

C. Acceptable Manufacturers:

1. Vent Fabrics, Inc.
2. Duro-Dyne
3. Advance Elastomeric Systems
4. or equal, as specificed elsewhere in Division 23.

2.9 Flexible Piping Connections

A. Application: Provide flexible piping connections between piping and vibrating equipment including but not limited to: pumps, cooling towers, air handling units coils and compressors.

B. Elastomeric Multi-sphere Connectors:
1. Construction:
a. Provide flexible piping connections to units listed above and similar at all connection points via flexible neoprene connectors consisting of multiple plys of nylon tire cord fabric and neoprene. Neoprene elements shall form at minimum a dual sphere muffler construction at each connection. Connectors up to and including 1-1/2" diameter may have threaded ends. Connectors 2" in diameter or larger shall be manufactured with floating metal flanges recessed to lock the connector's raised face neoprene flanges.
b. Connectors shall be rated a minimum of 150 psi at 220°F. Flanged equipment shall be directly connected to neoprene elbows in the size range of 2-1/2" to 12" diameter if the piping makes a 90 degrees turn at the equipment. All straight through connections shall be made via twin sphere configuration per 1 above.
2. Acceptable subject to above:
a. Safeflex SFDEJ by Mason Industrials, Inc.
b. C. Flex by MG Piping Products Company
c. Style 2600 by Amber/Booth Company
d. Merflex Style 5500 TS by Mercer Rubber Company
e. Type VMT by Vibration Mounting & Controls
f. or equal.

C. Metallic hoses:
1. Where application requires higher temperature pressure or unsuitable fluids, provide metallic hose in lieu of elastomeric connectors. Provide two each at every location where A applies above.
2. Provide flexible connectors fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Stainless steel grades shall be 304, 316, or 321 as required for the application. Live lengths shall be as indicated, but not less than that recommended by the manufacturer for continuous vibration application.
3. Provide in length as required by Part 3 of this Section.
4. Acceptable:

a. Type BBS, SS or BBF by Mason Industries, Inc.
b. Type BBS, SS or BBF by Mercer Rubber Company
c. Metal-Flex by Amber/Booth Company
d. Stainless steel flexible connectors by DME, Inc.
e. Type MFP by Vibration Mountings & Controls, Inc.
f. or equal.

2.10 Resilient Penetrations

A. For piping or ductwork, (Field Fabricated Method):
1. Sleeves: Sleeves of appropriate gage galvanized sheet metal shall be formed to at least the thickness of the penetrated construction and 3/4" to 1" larger in each cross-sectional dimension than the penetrating element.
   a. Acceptable:
      1) Century-Line Sleeves by Thunderline Corporation
      2) Custom by Contractor
      3) or equal.
2. Batt: Glass fiber of batt or mineral wool, 1 to 3 lb./cu. ft. density.
   a. Acceptable Manufacturers:
      1) Certain-Teed
      2) Johns-Manville
      3) Owens-Corning
      4) or equal.
3. Acoustical Sealant:
   a. Acceptable Manufacturers:
      1) DAP
      2) Pecora
      3) Tremco
      4) U.S. Gypsum
      5) 3M
      6) or equal.
4. Firestop Sealant:
   a. Where required, resilient firestop caulking may be used in lieu of Acoustical Sealant when installed in strict conformance with the manufacturer's directions. Fully hardened firestop caulk shall develop a Shore A hardness of no greater than 35.
      1) Acceptable, subject to approval for intended application by Authorities Having Jurisdiction:
         a) G.E. Pensil 100 Firestop Sealant
         b) Tremco Fyre-Sil Silicone Fire-stop Construction Sealant
         c) 3M Fire Barrier Sealant
         d) or equal.

B. For piping penetrations (Factory Fabricated Component Method):

1. A factory-fabricated sleeve assembly with outer sleeve of sheet metal and inner resilient liner of moisture-and vermin-resisting felt neoprene, glass fiber or foam rubber 1/2” to 3/4" thick and bonded to the sheet metal sleeve. Sleeve inside diameter shall be equal to outside diameter of penetrating element. Sleeve length shall be at least equal to the thickness of the penetrated construction. Sleeve shall be set and caulked airtight in penetrated construction and clamped tightly around penetrating element.
2. Acceptable:
   a. Mason Type SWS
   b. Peabody Type PS-1-D
   c. Potter-Roemer PR-Isolator
   d. Stoneman Engineering Trisolator
   e. B-Line B3195 Series
   f. or equal.
3. Where required, a fire rated factory fabricated sleeve and inner resilient liner of solid rubber links may be substituted for the preceding when installed in strict accordance with the manufacturer's instructions.
   a. Acceptable, subject to by Authorities Having Jurisdiction:
      1) Link Seal by ThunderLine Corp.
      2) or equal.

2.11 Supporting Devices

A. General
1. Supports to be sized to suit load and selected to match mounting conditions

B. Manufacturers
1. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:
   a. Concrete fasteners:
      1) Phillips "Red-Head"
      2) Remington
      3) Ramset
      4) Hilti
      5) Simpson Strong-Tie
      6) or equal.
   b. Concrete inserts and construction channel:
      1) Unistrut Corp.
      2) GS Metals "Globe Strut”
      3) Thomas & Betts "Kindorf" Corp.
      4) or equal.
   c. Conduit straps:
      1) O-Z/Gedney
      2) Erico "Caddy" Fastening Products
      3) Thomas & Betts "Kindorf" Corp.
      4) or equal.
   d. Beam Clamps:

1) Cooper B-Line
2) SuperStrut
3) Unistrut
4) or equal

e. Aircraft Cable Sway Braces:
1) Mason Industries
2) M.W. Vibrex/Saussé
3) Loos & Company, Inc.
4) or equal.

C. Concrete Fasteners
1. Provide expansion-shield type concrete anchors.
2. Provide powder driven concrete fasteners with washers. Obtain approval by Owner's Representative prior to use.

D. Concrete Inserts
1. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of 1/4" to 1/2" diameter thread for rod support.

E. Aircraft cable sway braces
1. Steel rope sized to meet load.

F. Construction Channel:
1. Construction:
a. 1-5/8" square galvanized channel formed from U.S.S.G No. 12 or 0.109" cold formed steel with 17/32" diameter bolt holes, and 1-1/2" on center in the base of the channel.
b. 10' sections.
2. All supporting materials by same manufacturer.

G. Beam Clamps
1. Malleable iron electro-galvanized steel beam clamps selected to match building structural steel members.

H. Conduit Straps
1. One hole strap, steel or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.
c. Use malleable strap with spacers for exterior and wet locations.
d. Use steel strap without spacers for interior locations.
2. Steel channel conduit strap for support from construction channel.
3. Steel conduit hanger for pendant support with threaded rod
4. Steel wire conduit support strap for support from independent #12 gauge hanger wires.

I. Threaded rods, couplings, screws and nuts:
1. Electrolytically coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123/A123M-09 or A153/A153M-09.

J. Miscellaneous Parts
1. Hot dipped galvanized after fabrication; after cutting, de-burring and hole drilling. Coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123/A123M-09 or A153/A153M-09.

K. Paint/Tape for Touch-up:
1. Zinc: CRC "Zinc-It", Glyptal, Enterprise Galvanizing “Galambra”, or equal.

2.12 Terminal Unit Acoustical Requirements

A. Testing: Terminal units shall be tested to, and comply with, all requirements of this Specification. Representative samples shall be subjected to tests in accordance with applicable standards and procedures in order to demonstrate such compliance.
1. All measurements shall be made in accordance with Air Diffusion Council Test Code No. 106R1, ASHRAE Standard 36-62 and ASHRAE Standard 36B-63.
2. The results of the tests shall be certified by the testing agency, and submitted to the Architect for approval. The submittal shall include a complete description of the test conditions and the measurement procedure.

B. Acoustical Criteria:
1. The maximum Sound Power Level (PWL) in dB re 10-12 watts and maximum Sound Pressure Level (SPL) in dB re 0.0002 dyne/cm2 of casing radiated and discharge noise shall be as specified herein; in-duct insertion loss shall also be established with the test method being described and certified.

Octave Band Center Frequency							
63	125	250	500	1000	2000	4000	8000
Maximum Casing Radiated SPL (in dB re 0.0002 dyne/cm2) 10' from critical occupancy (NC-35 or less)							
43	44	37	35	33	37	38	39
10' from less critical occupancy (NC-40 to NC-35)							
46	48	42	40	38	42	43	44
Maximum Casing Radiated Sound Power Level (PWL, dB re 10-12 watts) Any terminal unit feeding occupied space							
71	65	61	58	55	53	53	53
Maximum Discharge Sound Power Level (PWL dB re 10-12 watts)							
88	79	70	68	65	62	60	58

C. Lining: At casings, provide Acoustical Duct Lining as specified elsewhere herein.

2.13 Duct Lagging

A. Ductwork Mass Loaded Barrier
1. Construction:
a. Roll form, limp mass barrier with 0.5 pound per square foot surface weight unit.
b. 1” minimum layer of 0.7 pound per cubic foot nominal fiberglass blanket or batt. attached to mass layer and covered with a suitable mass to prevent erosion.
2. Minimum Acoustical Performance as follows:

Minimum Transmission Loss Requirements for Duct Lagging						
Frequency (Hz)	125	250	500	1000	2000	4000
Transmission Loss (dB)	12	13	16	21	27	32

3. Approvals:
a. Suitable for and listed by the manufacturer as suitable for installation in an environmental air plenum.
b. Manufacturers:
1) Kinetics Model KNM-100ALQ
2) Sound Seal Type B-10 Lag
3) Proudfoot Type NM/LAG
4) Inplant Enviro-Systems 2000 Type 1B LAG/QA-3
5) or equal.

PART 3 - EXECUTION

3.1 Inspection of Conditions

A. Examine related Work and surfaces before starting Work of this Section. Report to the Architect, in writing, conditions which will prevent proper provision of this work. Beginning the Work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.

3.2 General Installation Requirements

A. Vibration Isolation: Mechanical and associated electrical machinery, piping and ductwork shall be mounted on vibration isolators and seismic snubbers as indicated or specified and required to minimize transmission of vibrations and structure borne noise to the building structure or spaces. All mechanical equipment, unless otherwise noted, shall be isolated from the structure by means of resilient vibration and noise isolators.
   1. Rotating and reciprocating machinery shall be balanced statically and dynamically.

B. Stress: Installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Prior Approval: The Contractor shall not install any equipment, duct or piping which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to slabs, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems.

D. Rigid Contact: Prior to installation, the Contractor shall bring to the Architect's attention any conflicts between trades which will result in unavoidable rigid contact at equipment or piping or ducts, as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

E. Discrepancies: Prior to installation, the Contractor shall bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

F. Protection: Isolators exposed to the outdoors during construction shall either be designed for such exposure or shall be protected be suitable means.

G. Access: The Contractor shall obtain inspection and approval from the Architect of any installation to be covered or enclosed, prior to such closure.

H. Instructions: The Contractor shall obtain written instructions from the vibration isolation manufacturer as to the proper installation and adjustment of vibration isolation devices; alternatively, the equipment may be installed by the vibration isolation manufacturer.

I. After installation and before equipment start-up an authorized representative of the manufacturer shall visit the site, and shall inspect each isolator and certify in writing that each is installed in accordance with the manufacturer's instructions. Make all adjustments and corrections required by the manufacturer's representative to enable this certification.

J. Defective Installations: The Contractor shall correct, at no additional cost to the Owner, all installations which are deemed defective in workmanship or materials by the Architect or Consultant.

K. Field Quality Control
1. Testing and Inspection: See Section 01 45 00.
2. Testing of Concrete Anchors: Anchors drilled into concrete and which are to be loaded in tension (pull-out) will be proof-tested by the Owner to two times the maximum allowable load. 50% of all anchors will be proof-tested. In the event of a single failure, testing of all remaining anchors will be performed as directed by the Architect . Additional testing required because of a test failure shall be paid for by the Contractor.
3. Field Balancing:
a. Dynamic balancing of certain critical rotating equipment is required.
1) Maximum Permissible Machinery Vibration Levels:
a) Mechanical balance of rotating equipment as shown shall be field tested with final drives and couplings in place and with the units in normal operation.
2) Overall vibration amplitude 0.003” maximum peak-to-peak, for frequencies below 10 cycles/second (600 rpm) and 0.1-inch/second maximum peak velocity for frequencies above 10 cycles/second (600 rpm).
3) Take measurements on bearing housings (not end caps) or other heavy structural element directly connected to bearing housing at both ends of each unit.
4) Pulley runout in radial and axial directions shall be less than 0.001”.
5) Correct and retest equipment exceeding the limits for compliance.

3.3 Equipment Isolators

A. Structural Frames: Machine to be isolated shall be supported by a structural steel frame, Type RS, Type CI, Type BR, Type TS, Type RPA or Type IRSF frames as described herein.

B. Brackets: Brackets shall be provided as required to accommodate the isolator and provide a mechanical stop. The vertical position and size of the bracket shall be submitted by the isolator manufacturer.

C. Clearance: Operating clearance between the bracket and the pad or floor shall be 3/8”. The minimum operating clearance between the frame and the housekeeping pad or floor shall be 1", for rigid steel and 2" for concrete inertia base.

D. Shims: Frame shall be placed in position and the brackets supported temporarily by 3/8" shims prior to the installation of the machine or isolators.

E. Support: Isolators shall be installed without raising the machine and frame assembly.

F. Adjustment: Adjusting after the entire system installation is completed and under full operation load, the isolator shall be adjusted so that the load is transferred from the shims to the isolator. When all isolators are properly adjusted, the shims will be barely free and shall be removed. Thereafter, the shims will be used as a gauge to check that the 3/8" clearance is maintained so that the system will remain free of stress.

G. Roof curbs: Installation of Type IRSF shall be in strict conformance with the manufacturer's instructions.

3.4 Installation Requirements, Motion Restraints

A. Inspection: All installations shall be inspected and approved by a Civil or Structural Engineer licensed in the Project jurisdiction for adequate motion restraint and to assure that such does not short-circuit vibration isolators during normal operation. Adjustments, as reasonably required, shall be made by the Contractor at no expense to the Owner.

B. RPA: Independent Motion Restraint for type RPA shall be bolted directly to the support surface and to the equipment frame as indicated in the approved shop drawings. Vertical height restraint bolts shall be utilized to stabilize RPA during mounting and installation, and then disengaged. Following initialization of the unit to operating load, the height adjustment bolts shall be used to achieve final leveling at operating height. Install the specified independent Motion Restraint at this level, with a minimum of 1/8" clearance between restraint elements under normal operation. Manufacturer's instructions in this regard shall be explicitly conformed to. Following installation of Motion Restraint, vertical height restraint bolts provided with RPA shall be removed by cutting.

3.5 Piping and Duct Resilient Support and Suspension

A. Applies: Pipes included under this Section of the Specifications are refrigeration and heating water including that connected to vibrating equipment.

B. Does Not Apply: Piping not included is compressed air, piping not listed above, and fire standpipe and sprinkler piping.

C. Extent: Pipes and ducts connected to vibrating equipment shall be resiliently supported or suspended for a distance of 30 feet from such equipment. Refer to Part 2 for products. All connections to such equipment include flexible connections specified elsewhere in this Section in minimum lengths conforming to the recommendations in Table 43, Chapter 47, ASHRAE 2007 HVAC Applications.

D. Spring Hangers:
   1. Suspension Isolators shall be installed with the isolator hanger box as close as possible to the structure. Such isolators shall be suspended from substantial structural members, not from slab diaphragms unless specifically approved.
   2. Hanger rods shall be aligned to clear the hanger box.

3.6 Installation Requirements, Flexible Duct Connections

A. Alignment: Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection, so that duct opening nearly coincides and are almost equally spaced from one another all around. Do not install flexible connection until above requirements are met.

B. Free motion: Fans or fan casings and ducts shall be able to move 1" in any direction relative to each other without short-circuiting metal to metal or stretching taut the flexible connection.

3.7 Installation Requirements, Flexible Piping Connections

A. Application: Flexible piping connections shall be installed within 10 feet of all vibrating equipment, or prior to penetration of the building, whichever is shorter, on all piping connected to such equipment.

B. Placement: Flexible piping connections shall be located such that their length is at right angles to the principal direction of movement and thus such that the movement of the equipment does not alternately place the connection into tension and compression.

C. Length: Flexible piping connectors shall be installed in accordance with the manufacturer's recommended procedures and in lengths complying with section 3.5.C.

D. Braided metal hose: Where permitted as a substitution, shall be installed in pairs, one in the vertical plane and one in the horizontal plane at each location that a single flexible pipe is required in this section.

3.8 Installation Requirements, Resilient Penetrations

A. Application: Penetrations included in this Section of the Specifications include all piping and ducts connected to vibrating equipment within 30' of such equipment.

B. Alternate A for round or rectangular penetrations:
1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below and vertical framing between and to the sides, as required. Provide the above, escutcheon plates and such related construction as is necessary to make the penetrated structure as solid and massive near the penetrations as the surrounding construction.
2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster or drywall compound full depth and all around – but only to a maximum width of 1/2" – or the requirements of the above paragraph shall not have been satisfied.
3. Pack annular opening with glass fiber between metal sleeve and penetrating element full depth, all around to a firm degree of compaction. Leave a 1/2" deep annular opening free at each end of the metal sleeve; fill this fully with sealant.

C. Alternate B for round penetrations: Observe requirements above, except that use of sealant at sleeve ends is not required. In lieu of sealant, clamp factory-fabricated sleeve assemblies specified in Part 2 tightly around penetrating elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before sealing of sleeves to penetrated constructions. Refer to manufacturer's instructions for installation of fire-rated rubber link systems.

3.9 Installation Requirements, Duct Lagging

A. Determine the circumference of the duct to be wrapped and note additional length required due to lagging thickness. Add 2-3 inches overlap of product onto itself.

B. Once the material is cut to desired length, drape lagging over the duct with equal parts of the product hanging over each side. Bring one side up and adhere to duct with a foil lag tape. The other side is then brought up, overlapped over the product, and secured using the same tape.

C. On large rectangular ductwork, a mechanical fastener such as stick pins or weld pins should also be utilizes with emphasis on bottom support to prevent the product from sagging below the ductwork.

D. Cut additional sections in similar fashion as needed. Each progressive section should overlap the previous section by a minimum of 2 inches prior to the application of foil tape.

E. On the overlap seam as well as the circumferential seams that occur between rolls of lagging, apply foil lag tape. Add additional wraps of tape as required to securely fasten lagging to duct. Banding can be installed in addition to tape if lagging does not secure properly.

F. For corner and elbow installations, product should be cut similar to the gore method used in sheet metal construction.

G. Installation should assure there are no gaps or leaks.

3.10 Mechanical Room/Plenum Requirements

A. Airtight Enclosure: All mechanical rooms, plenums, duct shafts and drywall duct enclosures shall be constructed airtight. This means that every precaution shall be taken to maintain construction completely airtight around a room so designated. Construction joints, duct penetrations, electrical boxes, frames, supports, cabinets, doors, access panels, fixtures, etc., all shall be built or installed in such a manner as to prevent sound transmission through any construction enclosing a room horizontally or vertically. Appropriate lintels, frames, blocking, escutcheons, grouting, gaskets, packing, caulking, taping, filling, etc., all shall be employed to prevent sound transmission. Refer to requirements of this Section for Resilient Penetrations.

B. Discrepancies: All work under this section is to comply with the above. Mechanical Contractor to report to architect any construction conditions which arise which might compromise compliance with this requirement.

3.11 HVAC Ambient Noise Criteria

A. Criteria: The ambient noise levels resulting from HVAC equipment shall not exceed the noise criterion of (NC) levels scheduled below.

B. Contract Documents: The noise criterion scheduled herein have been utilized to determine the sizing of the sound traps and amount of acoustical lining of ductwork required to meet this criteria.

C. Field Design: Where field alterations are made to the design, main duct and branch duct velocities shall be sufficient to provide noise attenuation to the noise criteria scheduled herein.

MAXIMUM AIR SPEEDS IN DUCTS TO YIELD A GIVEN NC CONDITION
(with 2" inside duct lining or flexible duct, all duct sizes)

	NC-20	NC-25	NC-30	NC-35	NC-40	NC-45	NC-50

	SUPPLY	RETRN	SUPPLY	RETRN	SUPPLY	RETRN	SUPPLY	RETRN	SUPPLY	RETRN	SUPPLY	RETRN	SUPPLY	RETRN
Exit Velocity	280	330	340	400	410	480	500	580	600	700	730	850	880	1030
10 ft. before opening	310	380	370	460	450	550	550	670	660	800	800	970	970	1180
Next 20 ft.	420	500	500	600	610	730	738	880	890	1070	1080	1290	1310	1570
Next 20 ft.	550	660	670	800	810	970	980	1170	1190	1420	1440	1720	1740	2080
Next 20 ft.	640	780	780	940	940	1140	1140	1380	1380	1670	1670	2020	2020	2440
Next 20 ft.	820	990	990	1200	1200	1450	1450	1760	1760	2120	2130	2570	2570	3110

D. Return: Return air duct at the HVAC unit velocities shall be no greater than 2050 FPM and return diffuser face velocities shall be no greater than 880 FPM.

E. Supply: Supply air takeoff velocities shall be no greater than 3400 FPM and supply diffuser face velocities no greater than 750 FPM.

ROOM	TARGET NC
Closed Offices / Conference Rooms / Council Chambers / Gallery	30
Reception	35
Lobbies / Open Office / Breakroom / Kitchenette / Copy Room	40
Restrooms / Storage / Janitor Closets	45
Electrical / Mechanical / Telecom Rooms	50

END OF SECTION

SECTION 26 05 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work included in this Section: All materials, labor, equipment, services, and incidentals necessary to install the Electrical Work as shown on the drawings and as specified hereinafter, including, but not limited to the following:
   1. Electrical service provisions as outlined on the drawings, including temporary power for construction.
   2. Main switchboard, distribution panel, panels, transformers, and feeders.
   3. Branch circuit wiring, wiring devices and connections to all equipment requiring electrical service.
   4. Lighting fixtures completely lamped, including switches, raceways and wiring.
   5. Emergency egress/exit illumination system.
   6. Fire Alarm system.
   7. Mechanical equipment power connections, and motor starters where noted.
   8. Low voltage lighting control system and programming.
   9. Engine-Generator.
   10. Automatic Transfer Switch.
   11. Lighting system Inverter.
   12. All required incidental work, such as roof flashing, electrical testing, title 24 acceptance testing, and temporary power.
   13. Any other electrical work as might reasonably be implied as required, even though not specifically mentioned herein or shown on the drawings.
   14. It is the intent of the drawings and specifications that systems be complete and, except as otherwise noted, be ready for operation.

1.02 RELATED WORK

A. Division 1 - General Requirements

B. Division 9 - Finishes

C. Division 23 - Mechanical

D. Section 07270 - Firestopping

1.03 INCORPORATED DOCUMENTS

A. Requirements of the General Conditions, Supplementary Conditions, and Division 1 Sections apply to all work in this Section, unless modified herein.

B. Published specifications, standard tests or recommended methods of trade, industry or government organizations apply to work of this Section where cited by abbreviations noted below, unless modified herein.
   1. 2016 California Code of Regulations.

2. 2016 California Building Standards Administrative Code, Part 1, Title 24, C.C.R.
3. 2016 California Building Code (CBC), Part 2, Title 24, C.C.R. (Based on 2015 International Building Code with 2016 California Amendments).
4. 2016 California Electrical Code (CEC), Part 3, Title 24, C.C.R. (Based on 2014 National Electrical Code with 2013 California Amendments).
5. 2016 California Mechanical Code (CMC), Part 4, Title 24, C.C.R. (Based on 2015 Uniform Mechanical Code with 2016 California Amendments).
6. 2016 California Plumbing Code (CPC), Part 5, Title 24, C.C.R. (Based on 2015 Uniform Plumbing Code with 2016 California Amendments).
7. California Energy Code, Part 6, Title 24, C.C.R.
8. 2016 California Fire Code (CFC), Part 9, Title 24, C.C.R. (Based on 2015 International Fire Code with 2016 California Amendments).
9. 2016 California Green Building Standards (CALGreen) Code, Part 11.
10. American Society of Civil Engineers 7-10 (ASCE/SEI), Minimum Design Loads for Buildings and Other Structures.
11. Underwriters' Laboratories, Inc. (UL).
12. Local Utility Company regulations.

C. All State and Municipal Codes and Ordinances.

1.04 CONDITIONS AT SITE:

A. Visit to site is required of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.

B. Lines of other services that are damaged as a result of this work shall promptly be repaired at no expense to the Owner to the complete satisfaction of the Owner.

1.05 QUALITY ASSURANCE

A. Conformance:
   1. All work shall conform to the applicable requirements of Article 1.3 above.
   2. The Contractor shall notify the Architect, prior to submission of bid, about any part of the design, which fails to comply with abovementioned requirements.
   3. If after contract is awarded, minor changes and additions are required by aforementioned authorities, even though such work is not shown on drawings or covered in the specifications, they shall be included at Contractor's expense.

B. Coordination:
   1. The Contractor shall become familiar with the conditions at the job site, and with the drawings and specifications and plan the installation of the electrical work to conform with the existing conditions and that shown and specified so as to provide the best possible assembly of the combined work of all trades.
   2. The Contractor shall work out in advance all "tight" conditions, involving all trades and if found necessary, supplementary drawings shall be prepared by this Contractor, for the Architect's approval, before work proceeds in these areas. No additional costs will be considered for work, which must be relocated due to conflicts with the work of other trades.

3. The Contractor shall coordinate and verify all backbox, device, lighting fixture, or equipment mounting requirements with the devices or equipment to be installed, prior to rough in.

1.06 SUBMITTALS

A. Product Data:
   1. Comply with the provisions of Section 01 33 00 - Submittals.
   2. Within 15 days after award of the Contract, submit:
      a. Complete electrical, lighting, and signal systems material list of all items proposed to be furnished and installed under this Division. Provide manufacturers data sheets for all devices, raceways, fixtures, equipment, and related products to be used for the Division 26 and 28 work.
      b. Manufacturers' specifications and other data required demonstrating compliance with the specified requirements.
      c. Manufacturers' recommended installation procedures which, when approved by the Architect, shall become the basis for inspecting and accepting or rejecting actual installation procedures used on the work.
   3. Shop Drawings: Furnish shop drawings and/or equipment cuts for the following:
      a. Light fixtures including lamps and ballasts
      b. Main Switchboard, panel boards, and transformers. Panel board submittals shall include diagrams of the circuit breaker arrangements in the panels. Arrange circuit breakers in panels exactly as shown on the panel schedules in the construction documents.
      c. Fire alarm system
      d. Disconnect switches
      e. Motor starters
      f. Low voltage lighting control system
   4. Test Reports:
      a. Factory Tests: As specified for specific equipment.
      b. Field Tests: Performance tests as specified for specific equipment.
      c. Megger Tests: As specified under TESTING.
      d. When series rated circuit breakers are used, provide a letter from the manufacturer of the equipment confirming that U.L. series rating exists for all protective devices. State the available fault current from the Utility Company and indicate that the overcurrent devices exceed the available fault current at the respective point of protection.
      e. Special Seismic Certification documentation as per CBC Section 1616A and ASCE/SEI 7-10 requirements for all equipment defined as 'critical' with an importance factor of 1.5 in Paragraph 1.10.M.3 of this Section.
      f. Manufacturer's Seismic Certification or Project-Specific Design of Supports and Attachments for all other equipment and fixtures as per CBC Section 1616A and ASCE/SEI 7-10 requirements.
   5. Maintenance and Operating Manuals:
      a. Systems Description: Description of operating procedures.
      b. Controls: Diagrams and description of operation of each system.
      c. Equipment: Manufacturer's brochures, ratings, certified shop drawings, maintenance data, and parts lists with part numbers. Mark each sheet with equipment identification number and actual installed condition.

d. Materials and Accessories: Manufacturer's brochures, parts lists with part numbers, and maintenance data where applicable. Mark each sheet with identification number of system and location of installation.
e. The Maintenance and Operation Manual shall be presented in a three ring binder that has tabbed sections as stated below. Provide all information in each section as stated below.
    1) 26 2400:
        (a) Insert the approved submittals for the main switchboard and panelboards.
        (b) Provide the names, addresses and telephone numbers of the manufacturer and the two closest manufacturer's representatives of the equipment.
    2) 26 5101:
        (a) Insert the approved submittals for the light fixtures.
        (b) Highlight the lamp type that was installed for each light fixture.
        (c) Provide the names, address and telephone numbers of the manufacturer and the closest manufacturer's representative for each light fixture.
    3) 26 5101:
        (a) Insert the approved submittals for the motion sensing light control equipment.
        (b) Insert all operating instructions.
        (c) Provide the names, address and telephone number of the manufacturer and the closest manufacturer's representative of the equipment.
        (d) Include the manufacturer's recommended maintenance of the equipment.
    4) 26 5700:
        (a) Insert the approved submittals for the low voltage lighting control equipment.
        (b) Insert all operating instructions.
        (c) Provide the names, address and telephone number of the manufacturer and the closest manufacturer's representative of the equipment.
        (d) Include the manufacturer's recommended maintenance of the equipment.
    5) 28 3101:
        (a) Complete the “Record Of Completion” entirely.
        (b) In the “Download File” indicate the exact equipment that the Monitor Modules are monitoring. i.e. fire sprinkler flow switches, tamper switches, etc..
        (c) Simplify the Download File so that it coincides with the submitted and approved fire alarm single line diagram.
        (d) Provide the names, address and telephone number of the manufacturer and the closest manufacturer's representative of the equipment.
        (e) Include the manufacturer's recommended maintenance of the equipment.
        (f) Insert an abbreviated data sheet that states how to test, reset and silence the fire alarm system.

(g) Insert the name and telephone number of the Central Station that receives the alarms, and the proper sequence to follow during an alarm.

6) 26 0800:
   (a) Insert all feeder and data system testing results.

7) 26 32 00 and 26 36 00
   (a) Insert the approved submittals for the generator, fuel tank, diesel particulate filter (if a filter is specified in Section 26 32 00), base tank alarm panel, automatic transfer switch(es), and remote annunciator.
   (b) Provide the names, address, and telephone numbers of the manufacturer and the two closest manufacturer's representatives of the equipment.
   (c) Insert all operating instructions.
   (d) Include the manufacturer's recommended maintenance of the equipment.

6. Record Documents: "As-builts": As specified under Paragraph 3.2 of this Section.

1.07 DELIVERY, STORAGE AND HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the work and materials of all trades.

B. Delivery and Storage: Deliver all materials to the job site in their original containers with all labels intact and legible at time of use. Store in strict accordance with approved manufacturers' recommendations.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

D. This Contractor shall personally, or through an authorized representative, check all materials upon receipt at jobsite for conformance with approved shop drawings and/or plans and specifications.

1.08 SCHEDULING/SEQUENCING

A. Place orders for all equipment in time to prevent any delay in construction schedule or completion of project. If any materials or equipment are not ordered in time, additional charges made by equipment manufacturers to complete their equipment in time to meet the construction schedule, together with any special handling charges, shall be borne by this Contractor.

B. The Contractor shall coordinate production and delivery schedule for all Owner-supplied equipment with the equipment suppliers to ensure that all Owner-supplied equipment is delivered to site in coordination with the construction schedule and in such a manner as to cause no delays in completion of the Contract as scheduled.

1.09 REQUIREMENTS

A. The contract drawings indicate the extent and general arrangements of the conduit wiring systems, etc. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted as soon as practicable, and within thirty-five (35) days after award of the electrical contract.

B. Unless material list and data is received as a complete and all inclusive submittal within the stipulated time all items shall be provided as specified, with no deviations permitted.

C. Any and all additional costs incurred by the substitution of electrical material or equipment, or installation thereof, whether architectural, structural, plumbing, mechanical or electrical, shall be borne by the Contractor under this Section.

D. Burden of proof of equality of any substitution for a specified product is the responsibility of this Contractor.

E. Where required by Architect to ascertain equality of substitute product, Contractor may be requested to provide the specified item and the submitted substitution for comparison, at no additional cost to the Owner.

1.10 SEISMIC CERTIFICATION AND INSTALLATION OF EQUIPMENT

A. See Architectural and Structural Drawings and Specifications for description of Occupancy Group and Seismic Design Category applicable to this project.

B. Provide Special Seismic Certification per CBC Section 1616A and ASCE/SEI 7-10 for all equipment and components defined as critical with an importance factor 1.5 in Paragraph 1.10.M.3 of this Section.

C. Special Seismic Certification shall require either certification through approved analytical method or approved shake table testing in accordance with Section 13.2.5 of ASCE/SEI 7-10 or experience data in accordance with Section 13.2.6 of ASCE/SEI 7-10.

D. Manufacturer's Seismic Certification or Project-Specific Design of Supports and Attachments for all other equipment and fixtures as per CBC Section 1616A and ASCE/SEI 7-10 requirements.

E. Provide seismic restraints per applicable code and as specified or indicated. Design restraints to prevent permanent displacement in any direction caused by lateral motion, overturning, or uplift.

F. Rigidly Supported Equipment, Conduits, and Raceways.

G. Lighting:
   1. Fasten lighting fixtures in suspended ceilings to ceiling grid system or otherwise support from the structures as specified herein and as per details indicated on the Drawings. Comply with California Electric Code (CEC) Article 410.
   2. Suspension systems for light fixtures shall allow fixtures to swing a minimum of 45 degrees from the vertical in all directions without contacting obstructions.

3. Free-swinging suspension systems shall have a safety wire or cable attached to the fixture and structure at each support. The wire shall be capable of supporting four times the weight of the lights.
4. Point-source fixtures: provide slack wires to structure at two diagonal corners.
5. Troffer fixtures: provide hold-down clip at each fixture corner, and slack wires to structure at two diagonal corners.
6. Supports for pendants: Provide diagonal seismic wire restraints per Code.

H. Components supported by chains or simply suspended from above are not required to meet lateral seismic force requirements and seismic relative displacement requirements provided that they cannot be damaged or cannot damage any other component when subject to seismic motion. They must have ductile or articulating connections to the structure at the point of attachment.

I. Electrical Cabinets:
1. Electrical cabinet design shall conform to National Electrical Manufacturers Association (NEMA) 250 and NEMA ICS6 standards. Cutouts in the lower shear panel that do not appear to have been made by the manufacturer and significantly reduce the strength of the cabinet are not permitted unless analysis demonstrates that the remaining strength is sufficient.
2. Single freestanding cabinets shall have a minimum of four anchor bolts designed and specified with one anchor located at each corner.
3. Multiple sections of cabinets or enclosures located adjacent to each other shall be bolted together. Minimum acceptable bolting is three bolts in the front and back along the adjacent vertical faces - 6 bolts total.
4. Multiple cabinets bolted together to form a section or line-up shall have at a minimum two anchors specified for each cabinet, one at the front and one at the rear.
5. Base anchorage shall be installed through anchor points designated by the Manufacturer. The largest bolt diameter for the anchor hole provided in the equipment shall be provided.
6. A latch or fastener to prevent opening during an earthquake event and damaging the cabinet and internal components shall secure all doors.
7. Slide-out components in electrical control panels, etc., shall have a latching mechanism to hold contents in place.
8. Attached cabling shall have adequate slack or flexibility between the cabinets and surrounding structure supporting the conduit to preclude severing of the cabling due to differential seismic displacements.

J. The design load shall include the effects of loading on the equipment imposed by attached utility or service lines that are also attached to separate structures.

K. The attachment of additional external items is not permitted unless such items have either been provided by the Manufacturer, or analysis shows that their effects are supported by design.

L. Conduit and their connections shall be constructed of ductile materials unless otherwise approved by the Architect. Conduits and their connections constructed of non-ductile materials (e.g., cast iron, no-hub pipe and plastic) shall have brace lengths reduced to one-half that allowed for ductile material.
1. All trapeze assemblies supporting conduit shall be braced to resist CBC design forces considering the total weight of the elements on the trapeze.
2. Seismic restraint spacing shall be in accordance with hanger spacing.

M. Critical Equipment:
   1. Design with importance factor of 1.5.
   2. Provide Special Seismic Certification for all equipment and components and their installation per CBC and ASCE/SEI requirements.
   3. Critical Equipment shall include the following:
      a. Fire Alarm system equipment.
      b. Lighting System Inverter.
      c. Emergency Generator
      d. Automatic Transfer Switch

N. Seismic Design Submittals: For all Critical Equipment included in paragraph 26 05 00.1.10.M.3.
   1. The Manufacturer of each item of critical equipment shall arrange for the testing or analysis by an approved agency of each component and assembly and its mounting system or anchorage.
   2. The Manufacturer shall submit a Certificate of Compliance for each item for approval by the Architect and by the Authority Having Jurisdiction.
   3. Based on Manufacturer's approved submittal, Contractor shall retain the services of a State of California registered Structural Engineer to prepare final installation details and drawings for equipment supports and attachments.
   4. Submit drawings of the equipment showing dimensions, support equipment, connections, and the proper anchorage locations.
   5. Equipment weight and weight distribution (e.g., center of gravity in elevation and plan).
   6. Thickness of sheet metal bases.
   7. Seismic Vibration Isolation Devices: Manufacturer's product information indicating class and type. Indicate load ratings as published manufacturer's data or shop drawings. Indicate proper orientation of devices on plan.
   8. Inertia bases and support frames.
   9. Specific details of restraints including anchor bolts and welds and maximum load at each location.

O. Independent Supports: An independent means of secure support shall be provided for all wiring methods in non-fire-rated assemblies. Where independent support wires are used, they shall be distinguishable by color, tagging, or other effective means.

1.11 DESCRIPTION OF WORK

A. This project involves the renovation of an existing building, as a portion of the existing building will remain. As such, the project scope for this contractor will include all associated electrical, lighting, and signal system upgrades and demolition/removal work at the existing site. The intent is that all new systems will be complete and functional at the completion of this contract and that all old systems, equipment, feeders, circuits, wiring, and related devices (no longer used) be completely and neatly removed. Where discrepancies between the drawings and existing conditions are noted, the project manager shall be notified immediately for resolution.

B. As with every renovation project, the electrical work will include (and require) exploration and other field work on a daily basis to complete the new designed equipment and connections within the constraints of the existing building and existing site conditions.

C. The contractor shall include as part of the base bid, sufficient labor hours to provide such exploration and field work throughout the duration of the project. Change orders for misc. coordination of existing conditions will not be approved unless specific and latent conditions are uncovered that warrant such additional compensation or require additional work not shown on the plans or implied by the designed conditions.

D. New raceways and wiring to new and renovated equipment are to be installed unless otherwise noted. Where raceways are installed in accessible concealed locations (i.e. unfinished spaces or electrical / mechanical / attic spaces), EMT with wire shall be used. Where new wiring is required to be routed through existing walls and ceilings that can not easilly be accessible for new conduit, MC cable or flex conduit and wiring may be installed, fished through and secured in each space as required by code. Non-metallic sheathed cable shall not be utilized on this project.

E. All new raceways shall be installed concealed and all new equipment installed flush, unless otherwise noted on the plans or in these specifications.

1.12 GUARANTEE

A. This Contractor shall guarantee that all work executed under this Section will be free from defects of materials and workmanship for a period of one (1) year or as per the General Conditions of this project, whichever is longer. Dates shall be from the date of final acceptance of the building. The contractor shall further guarantee that he will, at his own expense, repair and replace all such defective work, and all other work damaged thereby, which becomes defective during the term of the guarantee. Such repair or replacement shall be guaranteed for one (1) year from the date of repair or replacement.

1.13 PERMITS AND INSPECTIONS

A. This Contractor shall arrange for and obtain all required inspections.

B. The Contractor shall pay for all required permits and inspections.

C. Do not allow or cause any of the work to be covered or enclosed until it has been tested and/or inspected.

1.14 IDENTIFICATION

A. Switchboards, feeder circuit breakers in switchboards, panels, disconnect switches, motor starters, transformers, motor disconnect switches, cabinets, and other apparatus used for the operation of, or control of circuits, appliances or equipment, shall be properly identified by means of engraved laminated plastic descriptive nameplates mounted on apparatus using stainless steel screws. Nameplates shall have white letters with black background and be submitted to the Architect for approval. Cardholders in any form are not acceptable.

B. Provide p-touch style labeling of circuit designations for all receptacles on the project.

C. Each branch circuit of panel boards to have a permanently fixed number with load directory, mounted under celluloid on inside of cabinet door, showing circuit numbers and typewritten description of equipment supplied by breakers.

D. Provide label on all motors: "Caution. Automatic equipment. May start at any time."

E. Provide silk-screened or engraved identification labels on all switch box covers identifying specific loads that are not readily apparent to the user, including electroshades, projection screens, exhaust fans, etc.. Submit proposed labels to Architect for approval prior to manufacture of labels.

F. Provide identification of all pull boxes, junction boxes, and conduit stub-ups on the project as outlined below:
   1. For Power Feeders:
      a. Stencil cover with identifying circuit number.
      b. Lettering 1" high.
      c. Color of lettering black.
      d. Place lettering on cover in neat manner; run parallel to long sides of box.
   2. For branch circuits, grounding, communication, signal, and control systems boxes and blank conduit stub-outs:
      a. Paint inside back of each j-box, front of each cover, and ends of each blank conduit stub-out with identifying system color as listed below:

1)	120/208-volt	Blue
2)	Telephone/Data	Grey
3)	Ground system	Green
4)	Fire Alarm	Red
5)	Audio/Visual	Yellow
6)	Security	White
7)	Lighting control	Orange/White

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to applicable Division 26, 27, and 28 Sections for complete products specifications.

2.02 MATERIALS

A. Materials of the same type or classification, used for the same purpose, shall be the product of the same manufacturer.

2.03 ACCEPTABLE MANUFACTURERS

A. Materials shall be of make mentioned elsewhere in this specification. All materials shall be the best of their several kinds, perfectly new and approved by the Underwriters' Laboratories.

B. Where material, equipment, apparatus or other products are specified by manufacturer, brand name, type or catalog number, such designation is to establish standards of desired quality, style and utility and shall be the basis of the bid.

Materials so specified shall be furnished under the contract unless changed by written approval of the Architect. Where two or more designations are listed, choice shall be optional with this Contractor, but this Contractor must submit his choice for final approval.

2.04 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment where indicated in the technical sections for use by operation and maintenance personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions as directed. Attach or post operating instructions adjacent to each principal system and equipment including startup, proper adjustment, operating, lubrication, shutdown, safety precautions, procedure in the event of equipment failure, and other items of instruction as recommended by the manufacturer of each system or equipment. Provide weather-resistant materials or weatherproof enclosures for operating instruction exposed to the weather. Operating instruction shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

2.05 CATALOGED PRODUCTS/SERVICE AVAILABILITY

A. Materials and equipment shall be current products by manufacturers regularly engaged in the production of such products. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The 2-year period shall be satisfactorily completed by a product for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6,000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished. The equipment items shall be supported by service organizations which are reasonable convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the areas and conditions under which the work of this Section will be installed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Drawings:
   1. The general arrangement and location of wiring and equipment is shown on the electrical drawings and shall be installed in accordance therewith, except for minor changes required by conflict with the work of other trades.

2. The Contractor shall coordinate and verify all backbox, device, lighting fixture, or equipment mounting requirements with the devices or equipment to be installed, prior to rough in.
3. Drawings indicate the circuit and panel which supplies each device or fixture. Provide and install conduit and conductors to make all connections from panel to nearest device and from first device to additional devices on same circuit. Conduit size and fill shall satisfy NEC requirements. Two or three different phases supplied by a 3-phase panel may share a single neutral only if circuit positions are adjacent in the panel. Do not exceed 4 #12 or 3 #10 conductors in a ½" conduit, 7 #12 or 5 #10 in a 3/4" conduit, and 11 #12 or 9 #10 in a 1" conduit, unless otherwise noted. Provide common handle-tie on breakers for multi-wire branch circuits (with common neutral), per NEC. If more than three current carrying conductors are installed in one conduit, conductor size shall be increased as required per NEC. Do not share neutrals for branch circuit runs to electronic equipment or where noted on the drawings.
4. Drawings indicate the location of all light switches. Where fixtures in a room are controlled by more than one switch, the same lower case letter is drawn adjacent to a switch and each fixture controlled by that switch. Where no lower case letter is adjacent to a switch, all fixtures in the room are controlled by that switch. Provide and install conduit and wire from fixture to switch and between fixtures as required to accomplish switching shown. Do not route branch circuit wiring for light fixtures through switch boxes.
5. Drawings indicate location of all signal outlet boxes. Provide and install conduit system as required as required and complete system wiring, unless otherwise noted.
6. Control wiring is generally not shown on the plans. Contractor shall refer to control diagrams and provide and install all wiring and raceways required to make all interconnections.
7. All branch circuit wiring No. 12 or No. 10 as noted, all control wiring No. 14, except as noted next to "slash marks" on drawings, or as noted under "Wire," as specified herein.
8. All dimensions, together with locations of doors, partitions, etc. are to be taken from the Architectural Drawings, verified at site by this Contractor.
9. Maintain "as-built" records at all times, showing the exact location of concealed conduits and feeders installed under this contract, and actual numbering of each circuit. Upon completion of work and before acceptance can be considered, this Contractor must forward to Architect vellums (obtained from the Architect at cost) corrected to show the electrical work as installed.
10. Branch circuit conductors shall be #12 minimum and #10 minimum for runs longer than 150 feet.

B. Measurements: Before ordering any material or closing in any work, verify all measurements on the job. Any differences found between dimensions on the drawings and actual measurements shall be brought to the Architect's attention for consideration before proceeding.

3.03 FIELD QUALITY CONTROL

A. All workmanship shall be first class and carried out in a manner satisfactory to and approved by the Architect.

B. This Contractor shall personally, or through an authorized and competent representative, constantly supervise the work and so far as possible keep the same foreman and workmen on the job throughout.

3.04 COORDINATION

A. In electrical rooms, Contractor is responsible for installation of electrical equipment within the space provided. Contractor shall provide ¼" scale plans of electrical room layouts, and elevations of steel channel supports (where used or required) of electrical equipment for review and approval prior to any installation or rough-in

3.05 INSTALLATION/APPLICATION/ERECTION

A. All electrical raceways and devices shall be installed concealed (for raceways) and/or flush mounted (for devices), unless otherwise noted. Provide cut-in boxes and "fish" flexible MC or flex conduit and wire through existing walls to remain, unless shown otherwise on plans. Cut and patch to facilitate such installation to match adjacent and original finish.

B. All cutting, repairing and structural reinforcing for the installation of this work shall be done by the General Contractor in conformance with the Architect's requirements.

3.06 TEMPORARY LIGHTING AND POWER

A. Provide and install temporary lighting and power systems for the duration of construction, of adequate size to accommodate the required lighting and power loads. Coordinate with other trades to insure adequate sizing.

B. Provide distribution equipment as required to support all construction activities.

C. Pay all utility company charges (installation and energy) related to temporary power usage during construction.

3.07 FIRE STOPPING AND FIRE RATED PENETRATIONS

A. All electrical equipment mounted in, on, or through fire rated construction shall be installed to maintain the fire rating of the construction.

B. Provide fire rated pads (or other suitable assembly) around all electrical junction boxes in fire rated walls/ceilings/floors to maintain the fire rating.

C. Provide fire rated construction around all recessed light fixtures and/or panel board / cabinets mounted flush in fire rated walls to maintain the fire rating. Coordinate depth of construction with other trades to avoid conflicts.

D. Conduit sleeves shall be provided as a means of routing cables through fire-rated walls or floors. Openings in sleeves and conduits used for system cables and those which remain (empty) spare shall be sealed with an approved fireproof, removable sagging material. Sleeves which pass vertically from floor to floor shall be sealed in a similar manner using an approved re-enterable system. Additional penetrations

through rated assemblies necessary for passage of tel/data wiring shall be made using an approved method and permanently sealed after installation of cables.

3.08 ADJUSTING AND CLEANING

A. All electrical equipment, including existing equipment not "finish painted" under other sections, shall be touched up where finished surface is marred or damaged.

B. All equipment, lighting fixtures, etc., shall be left in clean condition, with all shipping and otherwise unnecessary labels removed there from.

3.09 SCHEDULES

A. Coordination: Coordinate installation of electrical items with the schedule for other work to prevent unnecessary delays in the total Work.

3.10 WARNING SIGN MOUNTING

A. Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

3.11 PAINTING OF EQUIPMENT

A. Factory Applied: Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA ICS 6 corrosion-resistance test, except equipment specified to meet requirements of ANSI C37.20 shall have a finish as specified in ANSI C37.20.

B. Field Applied: Paint electrical equipment as required to match finish or meet safety criteria. Painting shall be as specified in the respective equipment section.

3.12 TESTS

A. Testing and inspection: See Section 26 08 00 - Testing.

END OF SECTION

PART 1 - GENERAL

1.1 Work Included

A. Objective:
1. It is an objective of this specification to avoid propagation of noise from or into the sound sensitive spaces noted herein via openings and penetrations necessary to accommodate raceways, backboxes and related.

B. Description of Work: Furnish, install, assemble, set up, test (hereinafter "provide") the following systems and equipment in accordance with the Contract Documents.
1. Flexible connections at electrical conduits connected to vibrating equipment.
2. Provision of all Motion Restraints required by applicable codes for systems specified herein.
3. Provision of caulking and airtight junction box packing at penetration of sound rated wall assemblies.
4. Coordination of Airtight Installation requirements at Mechanical and Electrical Rooms and/or duct enclosures.

1.2 Related Work in Other Sections

A. Concrete, Division 03

B. Thermal and Moisture Protection, Division 07

C. Finishes, Division 09

D. Mechanical, Division 23

E. Plumbing, Division 22

F. Electrical, Division 26

1.3 Reference Standards

A. Standards: Provide equipment in accordance with the latest edition and revisions of all applicable standards and specifications of all appropriate agencies including, but not limited to, the following:
1. ANSI - American National Standards Institute
2. ASTM - American Society for Testing and Materials
3. ASA - Acoustical Society of America
4. NFPA - National Fire Protection Association

1.4 Quality Assurance

A. Codes: Perform installation in accordance with all applicable international, federal, state, county, municipal and local codes and regulations.

B. Conflicts: Present any conflicts between codes, regulations, specifications and/or requirements at least thirty (30) days prior to the commencement of the scheduled work.

C. Related Provisions: Division 01 – General Provisions, Division 26 – General Provisions: Apply to the work of this Section.

1.5 Coordination

A. Coordinate with Finish Systems, Piping Systems and Equipment, Water Cooling and Heating, Plumbing Systems, Heating, Ventilating and Air Conditioning sections for installation of Vibration Isolation. Coordinate Work of this Section with all other impacted trades.

1.6 Submittals

A. Refer to Division 01 for procedures.

B. Descriptive Data: Submit the following:
1. For each Motion Restraint, a stress analysis prepared by a Civil or Structural Engineer licensed to practice in the Project jurisdiction. Provide sufficient detail to permit architect and authorities having jurisdiction to verify compliance with all applicable Codes and these specifications.
2. An itemized list of all items of equipment to be fitted with flexible electrical connections.
3. Catalog cuts of the products to be applied as J-Box mastic and Acoustical Sealant, and a schedule of rooms to receive application of mastic and sealant at J-Boxes.

C. Shop Drawings: Submit the following and secure approvals prior to fabrication:
1. Drawings showing methods for isolation of conduits piercing mechanical room walls, slabs, beams, etc.
2. Drawing showing methods, numbers and details of Motion Restraints and anchors for equipment, frames, isolators, conduit, etc., including calculations as above.
   a. Where Contractor-proposed substitutions change the weight, size, configuration or other aspects of systems and equipment that will affect the performance of anchorages and/or supports, the Contractor shall submit calculations for proposed anchors and supports, and install them as shown in these calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.
   b. Where Contractor-proposed substitutions are claimed to have no effect on anchors and supports detailed on the Contractor Documents, Contractor shall submit information on sizes, weights, center of gravity and other relevant information to demonstrate this fact.
   c. Contractor shall submit details and calculations for all embedded inserts, drilled inserts and other fasteners for attachments of suspended components showing the load-carrying capacity of each device calculated in accordance with Chapter 16 of the California Building Code. The

calculations shall include the same certification and engineer's stamp as required above for seismic bracing.

d. For all anchorages and supports not detailed on the Contract Documents, Contractor shall submit details and calculations. The calculations shall include the same certification and engineer's stamp as required above for seismic bracing.

3. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, showing compliance and coordination with Code and the project Architectural, Structural and Mechanical Documents.
4. Details of flexible electrical connections for all typical conditions listed in the schedule provided above.
5. Details of J-Box and sealant application for all typical conditions listed in the schedule provided above.

PART 2 - PRODUCTS

2.1 Motion Restraints

A. Objective: Provide motion restraint at all vibration isolated piping and equipment. Design restraints to comply with applicable Code in Project Jurisdiction.

B. General properties:
1. Restraints shall permit adjustment during installation to insure sufficient clearance between vibration isolated element and rigid restraining device.
2. Restraints at base supported equipment shall include resilient neoprene pads at all potential contact areas between isolated equipment and rigid restraining element.
3. Restraints shall be selected to be capable of providing the after installation adjustment and clearance tolerances required under Part 3 of this Section.

C. Restraint Description:
1. Restraining devices at base supported vibration isolated equipment shall be as manufactured by Mason Industries, type "All Directional Double Acting Earthquake Snubber" or equal by Vibrex/Saussé.
2. Coordinate restraint bolt locations with the structural and mechanical drawings and conditions.
3. Restraints at suspended piping and equipment shall consist of stainless steel cables together with neoprene snubbers arranged to achieve the required all-directional restraint and sized to resist the forces defined. Shop Drawings shall indicate proposed method for achieving vertical restraint for ceiling suspended piping. Cables shall have sufficient slack to avoid short circuiting the vibration isolators.

2.2 Flexible Electrical Connections

A. Make electrical connections to vibrating equipment flexible as follows:
1. For conduit over 1" O.D. make electrical connections to vibrating equipment via a flexible expansion/deflection conduit coupling sized as required. Coupling shall have flexible and watertight outer jacket, internal grounding strap, plastic inner

sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit.
a. Acceptable:
i. XD Xpansion Deflection Coupling by Crouse-Hinds of Syracuse, N.Y.
ii. Type DF Expansion and Deflection fitting by Spring City Electrical Mfg. Co. of Spring City, PA.
iii. or equal.
2. For conduit under 1" O.D. utilize "flexible" conduit with slack at least 3' or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

2.3 J-Box Mastic

A. At all electrical boxes penetrating sound isolating partitions, utilize sheet form adhesive mastic as directed elsewhere herein.
1. Acceptable:
a. Insul-Pad by Dottie Corp.
b. Duct-Seal by Gardner Bender, Inc.
c. Duxseal by Manville
d. Outlet Pad by Lowry
e. Moldable Putty Pads by 3M
f. or equal.

2.4 Resilient Penetrations

A. For conduit: (Field Fabricated Method):
1. Sleeves: Sleeves of appropriate gage galvanized sheet metal shall be formed to at least the thickness of the penetrated construction and 3/4" to 1" larger in each cross-sectional dimension than the penetrating element.
a. Acceptable:
i. Century-Line Sleeves by Thunderline Corporation
ii. Custom by Contractor
iii. or equal.
2. Batt: Glass fiber of batt or mineral wool, 1 to 3 lb./cu. ft. density.
a. Acceptable Manufacturers
i. Certain-Teed
ii. Johns-Manville
iii. Owens-Corning
iv. or equal.
3. Acoustical Sealant:
a. Acceptable Manufacturers:
i. DAP
ii. Pecora
iii. Tremco
iv. U.S. Gypsum
v. 3M
vi. or equal.
4. Firestop Sealant:
a. Where required, resilient firestop caulking may be used in lieu of Acoustical

Sealant when installed in strict conformance with the manufacturer's directions. Fully hardened firestop caulk shall develop a Shore A hardness of no greater than 35.

b. Acceptable, subject to approval for intended application by Authorities Having Jurisdiction:
   i. G.E. Pensil 100 Firestop Sealant
   ii. Tremco Fyre-Sil Silicone Fire-stop Construction Sealant
   iii. 3M Fire Barrier Sealant
   iv. or equal.

B. For conduit penetrations (Factory Fabricated Component Method):
   1. A factory-fabricated sleeve assembly with outer sleeve of sheet metal and inner resilient liner of moisture-and vermin-resisting felt neoprene, glass fiber or foam rubber 1/2” to 3/4" thick and bonded to the sheet metal sleeve. Sleeve inside diameter shall be equal to outside diameter of penetrating element. Sleeve length shall be at least equal to the thickness of the penetrated construction. Sleeve shall be set and caulked airtight in penetrated construction and clamped tightly around penetrating element.
   2. Acceptable:
      a. Mason Type SWS
      b. Peabody Type PS-1-D
      c. Potter-Roemer PR-Isolator
      d. Stoneman Engineering Trisolator
      e. B-Line B3195 Series
      f. or equal.
   3. Where required, a fire rated factory fabricated sleeve and inner resilient liner of solid rubber links may be substituted for the preceding when installed in strict accordance with the manufacturer's instructions.
      a. Acceptable, subject to by Authorities Having Jurisdiction:
         i. Link Seal by ThunderLine Corp.
         ii. or equal.

PART 3 - EXECUTION

3.1 Inspection of Conditions

A. Examine related Work and surfaces before starting Work of this Section. Report to the Architect, in writing, conditions which will prevent proper provision of this work. Beginning the Work of this Section without reporting unsuitable conditions to the Architect constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.

3.2 General Installation Requirements

A. The Contractor shall not install any vibrating equipment or conduit attached thereto which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes, but is not limited to slabs, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems.

B. Prior to installation, the Contractor shall bring to the Architect's attention any conflicts between trades which will result in unavoidable rigid contact at equipment, conduit, piping, ducts, etc., as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

C. Prior to installation, the Contractor shall bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.

D. The Contractor shall obtain inspection and approval from the Architect of any installation to be covered or enclosed, prior to such closure.

E. The Contractor shall correct, at no additional cost to the Owner, all installations which are deemed defective in workmanship or materials by the Architect or Consultant.

3.3 Installation Requirements, Motion Restraints

A. All installations shall be inspected and approved by a Civil or Structural Engineer licensed in the Project jurisdiction for adequate motion restraint and to assure that such does not short-circuit vibration isolators during normal operation. Adjustments, as reasonably required, shall be made by the Contractor at no expense to the Owner.

3.4 Installation Requirements, Flexible Electrical Connections

A. The installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the aforementioned vibration isolation.
   1. Alternate 1: Install flexible conduit in a grossly slack loop form or shallow "U" form. Install stranded conductors with sufficient slack to accommodate maximum possible movement.
   2. Alternate 2: The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack, and free of strain in any direction. Install stranded conductors as above

3.5 Installation Requirements, J-Box Mastic

A. Application: All Division 26 work in sound isolating assemblies, including but not limited to mechanical rooms, electrical rooms and related to utilize backboxes for all services, including but not limited to low voltage communication, telephone and CATV. Installation of backboxes to conform with following:
   1. Space outlet boxes on opposite faces of the wall by more than 24" o.c. Connect by slack flexible conduit (2 times longer than distance between outlets).
   2. Cutouts for electrical boxes and penetrating piping/conduit shall be no more than 1/4" oversize.
   3. Caulk gap between drywall and electrical boxes and/or piping/conduit airtight with Acoustical Sealant. Apply J-Box mastic to back of all penetrating electrical boxes and press firmly at joint to wallboard to provide an airtight seal.

3.6 Installation Requirements, Resilient Penetrations

A. Penetrations included in this Section of the Specifications include all electrical conduit connected to vibrating equipment within 30' of such equipment. For penetrations of air-tight walls beyond this limit, refer to requirements of Division 07.
   1. Alternate A for round or rectangular penetrations.
      a. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below and vertical framing between and to the sides, as required. Provide the above, escutcheon plates and such related construction as is necessary to make the penetrated structure as solid and massive near the penetrations as the surrounding construction.
      b. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster or drywall compound full depth and all around – but only to a maximum width of 1/2" – or the requirements of the above paragraph shall not have been satisfied.
      c. Pack annular opening with glass fiber between metal sleeve and penetrating element full depth, all around to a firm degree of compaction. Leave a 1/2" deep annular opening free at each end of the metal sleeve; fill this fully with sealant.
   2. Alternate B for round penetrations: Observe requirements above, except that use of sealant at sleeve ends is not required. In lieu of sealant, clamp factory-fabricated sleeve assemblies specified in Part 2 tightly around penetrating elements, using built-in or field-supplied clamping devices. Apply clamping of sleeves to penetrating services before sealing of sleeves to penetrated constructions. Refer to manufacturer's instructions for installation of fire-rated rubber link systems.

3.7 Mechanical and Electrical Room Requirements

A. All mechanical and electrical rooms, plenums, duct shafts and drywall duct enclosures shall be constructed airtight. This means that every precaution shall be taken to maintain construction completely airtight around a room so designated. Construction joints, duct penetrations, electrical boxes, frames, supports, cabinets, doors, access panels, fixtures, etc., all shall be built or installed in such a manner as to prevent sound transmission through any construction enclosing a room horizontally or vertically. Appropriate lintels, frames, blocking, escutcheons, grouting, gaskets, packing, caulking, taping, filling, etc., all shall be employed to prevent sound transmission. Refer to requirements of this Section for Resilient Penetrations.

B. All work under this section is to comply with the above. Mechanical Contractor to report to architect any construction conditions which arise which might compromise compliance with this requirement.

END OF SECTION

SECTION 26 08 00

TESTING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work Included in This Section: All materials, labor, equipment, services, and incidentals necessary to perform the testing and inspection of the electrical work, including but not limited to the general systems noted below:
   1. Grounding System.
   2. Lighting System.
   3. Distribution System.
   4. Fire Alarm System.
   5. Low voltage lighting control system
   6. Lighting emergency inverter system
   7. Title 24 Acceptance Testing

B. Any other electrical work as might reasonably be implied as required, even though not specifically mentioned herein or shown on the drawings.

C. All work shall comply with Sections 26 05 00 and 26 27 00.

D. In addition to the general system tests and inspections indicated above, the Contractor shall retain the services of a recognized corporately and financially independent testing firm (ETI, Power Systems testing, or equal) for the purpose of performing the following inspections and tests. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections:
   1. System Grounding
   2. Switchgear
   3. Feeders

E. The purpose of these tests is to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

1.02 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and tests shall be in accordance with the International Electrical Testing Association - Acceptance Testing Specifications ATS-2009 (referred to herein as NETA ATS-2009).

1.03 QUALIFICATIONS

A. Qualifications of the Testing Firm shall be as listed in NETA ATS-2009.

PART 2 - PRODUCTS

2.01 THIS ARTICLE DOES NOT APPLY TO TESTING.

PART 3 - EXECUTION

3.01 GENERAL

A. Final test and inspection to be conducted in presence of the Authority having Jurisdiction (AHJ) or Inspector of Record (IOR). Test shall be conducted at the expense of, and managed by, the Contractor, at a mutually agreed time. Submit written test report of all tests, with test result values and overall outcome.

B. All portions of the electrical installation shall be inspected and tested to ensure safety to building occupants, operating personnel, conformity to code authorities and Contract Documents, and for proper system operation.

3.02 INSPECTIONS AND TESTS

A. Tests: Field tests shall be performed and reports submitted, as per Section 26 05 00, Part 1.
   1. Final Inspection Certificates: Prior to final payment approval, deliver to the Owner, with a copy to the Architect, signed certificates of final inspection by the appropriate local authority having jurisdiction.

B. Grounding System:
   1. All ground connections shall be checked and the entire system shall be checked for continuity. The resistance of the ground system shall be measured using a 3 point fall-of-potential method. The maximum ground resistance shall be three ohms. If the measured ground resistance exceeds three ohms, install an additional ground rod.
   2. Ground tests shall meet the requirements of the National Electric Code.

C. Lighting Systems:
   1. The interior and exterior lighting systems shall be checked for proper local controls and operation of entire installation, including the operation of the low voltage lighting control system.

D. Power Distribution System:
   1. Test main switchboard, distribution boards, and panel boards for grounds and shorts with mains disconnected from feeders, branch circuits connected and circuit breakers closed, all fixtures in place and permanently connected and grounding jumper to neutral lifted and with all wall switches closed.
   2. Test each individual circuit at each panelboard with equipment connected for proper operation. Inspect the interior of each panel.
   3. Check verification of color coding, tagging, numbering, and splice make-up.
   4. Verify that all conductors associated with each circuit are in same conduit.
   5. Demonstrate that all lights, jacks, switches, outlets, and equipment operate satisfactorily and as called for.

6. Perform megger tests of all distribution system feeders prior to energizing. All Cables failing megger tests or with evidence of damage shall be removed and replaced in their entirety (no splices), at no cost to the Owner. Damaged cables may not be field repaired without specific approval of the Architect.

E. Fire Alarm System: Verify that all equipment, components, and devices function as specified. Refer to Section 28 3101 for additional testing requirements.

F. Low Voltage Lighting Control System: Verify that all equipment, components, and devices function as specified. Refer to Section 26 5101 for additional testing requirements.

G. Title 24 Acceptance Testing: Contractor shall complete the requirements for Title 24 Acceptance Testing, as per CA Title 24, Part 6.
   1. Perform testing requirements as per Title 24 Lighting Acceptance requirements. Testing shall include construction inspection of installed controls, occupancy / motion sensor testing, manual daylighting controls testing, automatic time switch controls testing, and demand response system interface, as applicable.
   2. Complete and submit all required forms for complete Acceptance Testing.
   3. Obtain required review and approval of Acceptance Forms to allow final certificate of occupancy to be granted.

END OF SECTION

SECTION 26 09 36

MODULAR DIMMING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Modular dimming control systems.

B. Related Sections:
   1. Section 262726 - Wiring Devices
   2. Section 265113 – Interior Lighting Fixtures, Lamps, and Ballasts: Fluorescent lighting ballasts controlled by central dimming control system.

1.02 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
   1. C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

B. ASTM International (ASTM)
   1. D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight.

C. Canadian Standards Association (CSA)
   1. CSA C22.2 # 14 Industrial Control Equipment
   2. CSA C22.2 # 184 Solid-State Lighting Controls
   3. CSA C22.2 # 156 Solid-State Speed Controls

D. International Electrotechnical Commission
   1. (IEC) 801-2 Electrostatic Discharge Testing Standard.
   2. IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.

E. International Organization for Standardization (ISO)
   1. 9001:2000 – Quality Management Systems.

F. National Electrical Manufacturers Association (NEMA)
   1. WD1 (R2005) - General Color Requirements for Wiring Devices.

G. Norma Official Mexicana (NOM).
   1. NOM-003-SCFI Productos eléctricos - Especificaciones de seguridad (Electrical products - Safety Specifications)

H. Underwriters Laboratories, Inc. (UL):
   1. 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   2. 508 (1999) - Standard for Industrial Control Equipment.
   3. 1472 (1996) - Solid-State Dimming Controls.
   4. 924 (2003) - Emergency Lighting and Power Equipment

1.03 SYSTEM DESCRIPTION

A. Modular dimming control system
   1. Factory assembled dimming controls and interfaces and modules
   2. Low voltage wall stations and control interfaces.
   3. LED Drivers; 0-10V, Tu-Wire, ELV Reverse Phase interfaces.

1.04 SUBMITTALS

A. Submit under provisions of Section 013300.

B. Specification Conformance Document: Indicate whether the submitted equipment:
   1. Meets specification exactly as stated.
   2. Meets specification via an alternate means and indicate the specific methodology used.

C. Shop Drawings; include:
   1. Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
   2. Schematic of system.

D. Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years experience in manufacture of architectural lighting controls.

B. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.

C. Central dimming control system:
   1. Listed by UL specifically for the required loads. Provide evidence of compliance upon request.

1.06 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
   1. Ambient temperature: 0 degrees to 40 degrees C (32 degrees to 104 degrees F).
   2. Relative humidity: Maximum 90 percent, non-condensing.
   3. Lighting control system must be protected from dust during installation.

1.07 WARRANTY

A. Provide Manufacturer's Warranty:
   1. Standard 2-year warranty, Includes:

a. 100 Percent Replacement Parts for Manufacturer Lighting System Components
b. 100 Percent Manufacturer Labor Coverage to Troubleshoot and Diagnose a Lighting Issue
c. First–Available Onsite or Remote Response Time
d. 24 Hours Per Day, 7 Days Per Week Telephone Technical Support, Excluding Manufacturer Holidays
e. Remote Diagnostics for Applicable Systems

B. Provide Manufacturer's Technology Support Plan for 8 years covering 100 percent parts and 100 percent Manufacturer labor and additional benefits as described below beginning 2 years after system startup completion.

C. For ballasts, see section 265113 – Interior Lighting Fixtures, Lamps, and Ballasts.

1.08 MAINTENANCE

A. Make ordering of new equipment for expansions, replacements, and spare parts available to end user.

B. Make new replacement parts available for minimum of ten years from date of manufacture.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer: Lutron Electronics Co., Inc. – System: Lutron GRAFIK Eye 3000 (to match existing).

B. Basis of design product: Lutron GRAFIK Eye 3500 or subject to compliance and prior approval with specified requirements of this section:
1. Lutron GRAFIK Eye 3500

C. Substitutions: Not permitted (to match existing).

2.02 GENERAL

A. Provide system hardware that is designed, tested, manufactured, and warranted by a single manufacturer.

B. Architectural Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F) and 90 percent non-condensing relative humidity.

C. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairmentper IEC 801-2.

2.03 DIMMING PERFORMANCE REQUIREMENTS

A. Electrolytic capacitors to operate at least 20 degrees C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40 degrees C (104 degrees F) ambient temperature.

B. Load Handling Thyristors (SCRs and triacs), Field Effect Transistors (FETs), and Isolated Gate Bipolar Transistors (IGBTs): Manufacturer’s maximum current rating minimum two times control’s rated operating current.

C. Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer.

D. Design and test dimmers to withstand line-side surges without impairment to performance.
   1. Control Units: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41 and per IEC 61000-4-5 surge requirements.
   2. Other power handling devices: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 200 amps per ANSI/IEEE C62.41.

E. Utilize air gap off, activated when user selects “off” at any control to disconnect the load from line supply.

F. Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (dimmed setting, full on, or off) prior to power interruption within 3 seconds.

G. Multiple load type, tested to UL 508 to specifically control incandescent/tungsten, magnetic low voltage, electronic low voltage, neon/cold cathode, fluorescent dimming ballasts, and non-dim loads.

H. Each dimmer to be assigned a load type that will provide a proper dimming curve for the specific light source.

I. Possess ability to have load types assigned per circuit, configured in field.

J. Minimum and maximum light levels user adjustable on circuit-by-circuit basis.

K. Control all light sources in smooth and continuous manor. Dimmers with visible steps are not acceptable.

L. Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage/cycle), frequency shifts (plus or minus 2 Hz change in frequency/second), dynamic harmonics, and line noise. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment to meet these requirements.

M. Systems not providing cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.

N. Each dimmer to incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.

O. Line Voltage Dimmers; Meet following load-specific requirements:
   1. Magnetic Low Voltage (MLV) transformer:
      a. Contain circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472, Section 5.11.
      b. Dimmers using back-to-back SCR construction that could fail open causing DC power to flow into magnetic low voltage load are not acceptable.
   2. Electronic Low Voltage (ELV) transformer:
      a. Dimmer to operate electronic low voltage transformers via reverse phase control. Alternately, forward phase control dimming may be used if dimming equipment manufacturer has recommended specific ELV transformers being provided.
   3. Neon and cold cathode transformers:
      a. Magnetic transformers: UL listed for use with normal (low) power factor magnetic transformers.
      b. Electronic transformers: Must be supported by the ballast equipment manufacturer for control of specific ballasts being provided.

P. Low Voltage Dimming Interface; Meet following requirements:
   1. Coordination between low voltage dimming module and line voltage relay: Capable of being electronically linked to single zone.
   2. Single low voltage dimming module; capable of controlling following light sources:
      a. 0-10V analog voltage signal.
         1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         2) Sink current via IEC 60929.

2.04 POWER INTERFACES

A. Products: PHPM-PA-DV; PHPM-PA-120; PHPM-3F-DV; PHPM-3F-120; PHPM-SW-DV; NGRX-PB; GRX-FDBI; ELVI-1000; GRX-TVI; GRX-PWM; HP-2; HP-4; HP-6.

B. Electrical:
   1. Phase independent of control input.
   2. Dimmer to meet limited short circuit test as defined in UL 20.

C. Diagnostics and Service: Replacing power interface does not require re-programming of system or processor.

2.05 WALL STATIONS

A. Line Voltage Wall Stations:
   1. Preset Lighting Control with Zone Override; Lutron Grafik Eye GRX-3500:
      a. Intensity for each zone indicated by means of one illuminated bar graph per zone.
      b. Fade time indicated by digital display for current scene while fading.
      c. Incorporate built-in wide angle infrared receiver.
      d. For temporary local overrides, individual raise/lower buttons to allow zones to be adjusted without altering scene values stored in memory.

B. Low Voltage Wall Stations:
   1. Product: seeTouch.

2. Electronics:
   a. Use RS485 wiring for low voltage communication.
3. Functionality:
   a. Upon button press, LEDs to immediately illuminate.
   b. LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or the LEDs turn off if the button press was not processed.
   c. Allow for easy reprogramming without replacing unit.
   d. Replacement of units does not require reprogramming.
   e. Provide faceplates with concealed mounting hardware.
4. Engrave wall stations with appropriate button, zone, and scene engraving descriptions furnished prior to fabrication.
5. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

C. Color:
   1. Color to match existing Grafik Eye 3506.
   2. Color variation in same product family: Maximum delta E=1, CIE L*a*b color units.
   3. Visible parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

D. Provide faceplates with concealed mounting hardware.

E. Engrave wall stations with appropriate button, zone, and scene engraving descriptions furnished prior to fabrication.

F. Silk-screened borders, logos, and graduations to use graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.

2.06 LOW VOLTAGE CONTROL INTERFACES

A. Astronomical Timeclock and Programmer Interface; Lutron Model GRX-CI-PRG:
   1. Provide ability to communicate by means of RS232 serial communication to GRX-4000 series system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 50 feet (15 meters) of RS232 source.
   2. Provide ability to communicate by means of TCP/IP over Ethernet to GRAFIK Eye 4000 system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
   3. Astronomical time clock and programmer interface
      a. Provide access to:
         1) Scene selections.
         2) Fade zone to a level.
         3) Fine-tuning of preset levels with scene raise/lower.
         4) Lock out scenes and zones.
         5) Fine-tuning of light levels with individual zone raise/lower.
         6) Enable/disable wall station.
      b. Software to provide as follows:
         1) System setup
            (a) Program low voltage controls.
            (b) Set up and run time clock schedules.

(c) Set up and run sequences.
(d) Set and report time.
(e) Archive system information.
2) Provide status monitoring through button feedback and scene-status updates.

B. Ethernet Interface; Lutron Model GRX-CI-NWK-E:
1. Ethernet Interface
a. Provide ability to communicate by means of TCP/IP over Ethernet to GRAFIK Eye 4000 system by means of user-supplied PC or digital audiovisual equipment. Control to be located within (1000 meters (300 feet) of Ethernet source.
2. RS232 and Ethernet Interface
a. Provide access to:
1) Scene selections.
2) Fade zone to a level.
3) Fine-tuning of preset levels with scene raise/lower.
4) Lock out scenes and zones.
5) Fine-tuning of light levels with individual zone raise/lower.
6) Enable/disable wall station.
b. Provide status monitoring through button feedback and scene-status updates.

2.07 ACCESSORIES

A. Emergency Lighting Interface; Lutron LUT-ELI
1. Provides total system listing to UL924 when used with Lutron GRAFIK Eye 4000 system.
2. Senses all three phases of building power.
3. Provides an output to power panels if power on any phase fails.
4. Accepts a contact closure input from a fire alarm control panel.

B. Tamper Proof Covers:
1. Locking covers for preset control units and wall stations: Reversible to allow lock to be located on either side of control.
2. Compatible with IR controls.
3. Does not reduce specified IR range by more than 50 percent of its original specification.

C. Infrared Transmitters:
1. Provide wireless remote control capable of recalling preset light levels for [four] [eight] scenes plus “off” and of fine-tuning light levels with master raise/lower.
2. Designed for use in conjunction with compatible infrared receiver and lighting control; dependent on that receiver, not transmitter.
3. Operate up to 15 meters (50 feet) within line-of-sight to that receiver.
4. “Learnable” by other variable frequency remote controls.

2.08 SOURCE QUALITY CONTROL

A. Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions.

B. Provide complete installation of system in accordance with Contract Documents.

C. Define each dimmer's load type, assign each load to a zone, and set control functions.

D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.

E. Systems Integration:
   1. Equipment Integration Meeting Visit (LSC-INT-VISIT)
      a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures.]

3.02 SERVICE AND SUPPORT

A. Startup and Programming
   1. Provide telephone startup assistance to Electrical Contractor or End User Representative (when available, in accordance with manufacturer's guidelines. Otherwise, onsite startup will be utilized.)
      a. Provides access to a Factory Certified Telephone Startup Technician during normal business hours.
      b. Provides telephone instruction and guidance for a complete system functional test.
      c. With phone startup completion and End User Registration, the 1-year parts-only warranty will be upgraded to the Standard 2-year Warranty.]
   2. Provide factory-certified field service engineer to a site visit to ensure proper system installation and operation under following parameters:
      a. Qualifications for factory-certified field service engineer:
         1) Minimum experience of 2 years training in the electrical/electronic field.
         2) Certified by the equipment manufacturer on the system installed.
      b. Make a visit upon completion of installation of modular dimming control system:
         1) Verify connection of power feeds and load circuits.
         2) Verify connection and location of controls.
         3) Program system data.
         4) Verify proper connection of digital control link.
         5) Verify proper operation of manufacturers interfacing equipment.
         6) Obtain sign-off on system functions.
         7) User to be trained on system operation.
   3. After Hours Start-up (LSC-AH-SU)
      a. Provide factory certified Field Service Engineer to perform manufacturer's start-up procedures outside normal working hours (Monday through Friday, 7a.m. to 5 p.m.)]

B. Tech Support

1. Provide factory direct technical support hotline 24 hours per day, 7 days per week.

3.03 FIELD QUALITY CONTROL

A. Manufacturer Services
   1. Aim and Focus Visit (LSC-AF-VISIT)
      a. Facility Representative to coordinate on-site meeting with Lighting Control System Manufacturer and Lighting Design Consultant to make required lighting adjustments to the system for conformance with the Lighting Design Consultant's original design intent.]
   2. System Optimization Visit (LSC-SYSOPT)
      a. Lighting Control System Manufacturer to visit site 6 months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.]

3.04 CLOSEOUT ACTIVITIES

A. Training Visit (LSC-TRAINING)
   1. Lighting Control System Manufacturer to provide 1 day additional on-site system training to site personnel.]

B. On-site Walkthrough (LSC-WALK)
   1. Lighting Control System Manufacturer to provide a factory certified Field Service Engineer to demonstrate system functionality to the Commissioning Agent.

3.05 MAINTENANCE

A. Capable of providing on-site service support within 24 hours anywhere in continental United States and within 72 hours worldwide except where special visas are required.

B. Offer renewable service contract on yearly basis, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system startup.

END OF SECTION

SECTION 26 24 00

SERVICE AND DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work Included in This Section: All materials, labor, equipment, services and incidentals necessary to install the electrical work as shown on the drawings and as specified hereinafter, including but not limited to the work listed below.

B. Underground service distribution conduits where noted, for power service coductors by utility company, including utility company coordination.

C. Temporary power for construction.

D. Concrete pad and ground rods for Utility installed padmounted transformer.

E. Main switchboard, Distribution Panels, Distribution System, Panel Boards, Grounding, and Overcurrent Protective Devices.

F. All required incidental work, such as excavating, backfilling, testing, and temporary power.

G. Any other electrical work as might reasonably be implied as required, even though not specifically mentioned herein or shown on the drawings.

H. All work shall comply with Sections 26 05 00 and 26 27 00.

1.02 RELATED WORK

A. Division 09 - Finishes

B. Division 23 - Heating, Ventilating, and Air Conditioning

1.03 SUBMITTALS

A. Comply with the provisions of Section 26 05 00 - Submittals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to Section 26 05 00, Part 2 - Products

B. All new equipment shall match existing.

C. List of Equipment Manufacturers:

Main Switchboard and Motor Control Center

Cutler Hammer, General Electric, Industrial Electric Manufacturing, Electrical Power Products, Square D.

Panelboards and Distribution Panel

Same manufacturer as main switchboard.

2.02 MATERIALS

A. Provide and install conduits for primary cables by utility company, concrete pad and grounding for utility company transformer, and conduit for secondary service cables by utility company, to main switchboard. Comply with all Utility Co. requirements.

B. Grounding:
   1. Provide and install grounding system as noted on the Drawings.
   2. Grounding electrode conductor: bare stranded copper type, #4/0 minimum.
   3. Install ground wires in rigid conduit.
   4. All grounding electrode conductor connections "thermite" or "cad-weld" welded.
   5. Use approved pressure type solderless connector or use fusion welding for all connections to and bonding of grounding electrode system. All connections shall be visible, readily accessible for testing purposes. Grounding electrode conductor between the grounding electrode and service equipment: Minimum #4/0.
   6. Furnish and install solid copper 5/8" x 10'-0" ground rod(s). Where multiple ground rods are shown, install a minimum of 20'-0" apart. Install ground rods in accessible boxes with covers. Furnish and install 2-#4/0 bare copper cables between multiple ground rods and main switchboard ground bus.
   7. Terminate grounding conduits at equipment with ground bushing, with ground wire connected through bushing.
   8. Provide No. 12 stranded (green) THHN conductor from outlet box to ground screw of every receptacle.
   9. Ground all isolated sections of metallic raceways.
   10. Provide #12 minimum stranded (green) THHN conductor sized per NEC, or as noted, connected continuously throughout branch circuit for all circuits, bonded to panel ground bus, and to all electrical devices and equipment enclosures.
   11. Grounding electrode installed as follows:
      a. Place #4/0 bare copper cable in foundation trench; tensioned, supported in such a manner that it cannot be less than two (2) inches from bottom or side of concrete when foundation concrete is poured; not less than one hundred feet of conductor. Embed in foundation with a loop at approximate center, brought out at top of foundation adjacent to building service equipment for connection to service equipment and for bonding to other parts of the grounding system.
      b. Use approved pressure type solderless connector or use fusion welding for all connections to grounding electrode. Connection visible, readily accessible for testing purposes. Grounding electrode conductor between the grounding electrode and service equipment: Minimum #4/0.
      c. Connect grounding electrode system to metallic water service entry metallic cold water pipe (if available) with nonferrous clamp and bare copper cable (sized as required) in conduit. Connection shall be accessible for inspection.
      d. Connect grounding electrode system to building steel as noted on Drawings. Use exothermic weld, connection shall be accessible for inspection.

e. After installation, test system using the three-point fall of potential method only. Record results and submit to Architect for approval. If resistance to ground exceeds three (3) ohms, install additional ground rods, bonded and interconnected to grounding electrode system.

C. Main Switchboard:
1. General: Switchboard shall be distribution panel type, metal enclosure with ground bus and insulated full capacity neutral bus.
2. Equipment:
   a. The switchboard shall be braced for a short circuit current of 50,000 amps. Bracing shall be per NEMA and UL standards.
   b. The switchboard shall comply with all the requirements of the Utility Company.
3. The switchboard shall be floor-mounted, self- supporting, dead-front and rear, front-operated, front-connected, distribution type. The enclosure shall be 90 inches high, made of cold rolled steel on a structural shape, or formed, steel frame and shall be mounted on two 3-inch, 5-pound continuous channel iron sills, which shall be closed at the ends between the two channels.
4. This contractor is responsible for the complete installation of the new switchboard within the space provided (both vertical and horizontal) and shall verify and/or coordinate all dimensions prior to ordering equipment. Proper allowances should be included to allow complete installation and erection.
5. The switchboard shall be a minimum of 20 inches deep and shall be constructed of National Electrical Code (NEC) gauge steel.
6. The switchboard shall be provided with a cable pull section at the top of the switchboard. Provide a minimum 12 inches of vertical clearance between the cable terminal lugs bolted to the switchboard busses and the top and bottom of the switchboard enclosure. Horizontal pull sections and gutters shall be kept free and clear of busses. Where busses cross vertical pull sections, the busses shall be insulated.
7. All connections between bus bars shall be of a bolted type using Belleville washers. Clamps will not be accepted. All bus bars shall be accurately formed, and all holes shall be made in a manner which will permit bus bars and connections to be fitted into place without being forced.
8. The design of all current-carrying devices or parts of the switchboard shall conform to the standard specified in the related sections of Underwriters' Laboratories, Inc. (UL) No. UL-891 and National Electric Manufacturer's Association (NEMA) Standard PB-2, except as these characteristics may be modified herein.
9. Bus bars, connection bars and wiring on the back of the switchboard shall be arranged so that maximum accessibility is provided for cable connections from the front.
10. Ampere ratings for rectangular bus bars shall be in accordance with the temperature rise standard of National Electric Manufacturer's Association (NEMA) and the Underwriters' Laboratories, Inc. (UL).
11. The enclosure shall be chemically cleaned by parkerizing, bonderizing or phoshorizing as a unit after all welding has been completed. The enclosure shall then be painted with a rust- resisting primer coat of paint and shall be finished with a coat of light gray, baked enamel.

12. Each section shall be bussed for the full connected load of that section. Extend bussing to spare circuit breaker "Spaces." Drill busses for future circuit breakers, and provide breaker connector hardware as required.
13. Provide copper bus bars and connections with silver-plated contact surfaces.
14. The contact surfaces and studs of all devices to which bus connections are made shall also have silver-plated surfaces.
15. Provide a 200% rated neutral bus for panels supplied with 200% rated feeders (incoming or outgoing). Refer to single line riser diagram for feeder ratings.
16. Locate ground bus, with a cross-section equal to at least 25 percent of the capacity of the main bus rating, in the back of the switchboard and extend bus throughout the length of the switchboard assembly. Ground each housing of the assembly directly to this bus.
17. Rigidly support all bus and connection bars and current transformers.
18. Fit all nuts and connections with locking devices to prevent loosening.
19. Provide load connections with solderless lugs. Factory-install all devices shown on Drawings as specified herein.
20. Provide a bonding strap from the equipment ground bus to the neutral bus.

D. Panelboards:
1. Surface or flush mounted, with branch circuits as shown on drawings.
2. Enclosures: code gauge galvanized sheet steel with welded full flange end pieces, stretcher- leveled steel trim, backpan and door.
3. Bussing of copper with silver-plated contact surfaces.
4. Provide a 200% rated neutral bus for panels supplied with 200% rated feeders (incoming or outgoing). Refer to single line riser diagram for feeder ratings.
5. Trims on surface-mounted cabinets secured with nickel-plated screws with cup washers, bottom of all trims to have lugs for resting on cabinet flange.
6. Panels shall be 20 inches minimum in width, provided with approved gutter space, barriers and adjustable supports. Doors mounted with concealed hinges provided with combination spring latch and lock. Doors and trims and surface mounted cabinets primed and finished with one coat baked on gray enamel. All visible panel enclosures and covers in finished (occupied) areas shall be painted to match adjacent wall finish.
7. Breakers on same phase to be aligned horizontally. Each panel provided with 5-handle locks.
8. Each branch circuit of panelboards to have a permanently fixed number with one word directory, mounted under celluloid on inside of cabinet door, showing circuit numbers and typewritten description of outlets controlled by breakers. Color code mains and each breaker terminal, same as conductor insulation.
9. Each panel shall be equipped with a copper ground bus.
10. All panels shall be fully bussed to accept future circuit breakers.
11. Panel board submittals shall include diagrams of the circuit breaker arrangements in the panels. Arrange circuit breakers in panels exactly as shown on the panel schedules in the construction documents.

E. Circuit Breakers:
1. General: Circuit breakers shall be molded case rated for 480 or 240 volts, multiple or single pole and amperage rating as shown on the drawings, bolt on, manually operated with "de-ion" arc chutes.
2. Main circuit breaker shall be shall be rated to interrupt the available short circuit current 42,000 amps RMS.

3. Distribution circuit breakers shall be rated for the amps interrupting capacity noted on the drawings or U.L. series rated with the main circuit breaker.
4. Branch circuit breakers shall be rated for the amps interrupting capacity or U.L. series rated with the distribution and main circuit breakers, General Electric type THQB or equal, minimum 10,000 A.I.C for 120/208 volt; type TEY or equal, minimum 14,000 A.I.C for 277/480 volt.
5. Where mechanical equipment is U.L. listed for overcurrent protection with fuses or HACR type circuit breakers, provide fuses where a fused switch is shown. Where the overcurrent protection is a circuit breaker provide HACR, (HACR means Heating, Air-Conditioning and Refrigeration) type.

F. Magnetic starters: shall be rated in accordance with latest published NEMA standards for size and horsepower rating, Westinghouse A-200 series or equal. Provide with overload sensor in each phase, hand-off-auto switch, red "run" pilotlight, in NEMA 1, NEMA 4X, or NEMA 3R enclosure or in motor control center where indicated. Coil shall be rated 120 VAC. Starters shall be across-the-line nonreversing unless otherwise noted.
   1. Contacts: Across-the-line magnetic starters shall be equipped with double break silver alloy contacts. All contacts shall be replaceable without removing power wiring or removing starter from panel. The starter must have straight-through wiring.
   2. Coils: Coils shall be of molded construction. All coils shall be replaceable from the front without removing the starter from the panel.
   3. Overload Relays and Thermal Units: Overload relays shall be the melting alloy type with a replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. The starter shall be inoperative if the thermal unit is removed.

2.03 ARC FLASH EVALUATION STUDY

A. An arc flash evaluation study shall be performed to determine, in coordination with the Owner’s safety policy, the required personal protective equipment (PPE) when working on energized equipment.

B. The arc flash evaluation study shall comply with all NFPA 70E and OSHA requirements for calculating and identifying incident energy levels and the corresponding PPE that would be required in each instance.

C. The calculated incident energy levels and recommended PPE for each location shall be summarized in a tabulated form listing location, circuit identification, and PPE. Discrepancies, problem areas, or inadequacies shall be promptly brought to the Architect's attention.

D. Arc flash calculations shall be based on values of fault current magnitudes identified in the short-circuit analysis and the associated clearing times of the over current protective devices determined by the coordination study. The settings recommended by the coordination study shall be the basis of arc flash calculations.

E. Calculation methods shall comply with IEEE Standard 1584 “IEEE Guide for Performing Arc-Flash Hazard Calculations”.

F. Per IEEE Standard 1584, a maximum arc time of two seconds shall be utilized to limit incident energy values.

G. Recommended settings of all protective equipment based on the short circuit and equipment coordination study shall be implemented prior to attaching arc flash hazard labels to the equipment.

H. All electrical equipment shall be field marked to indicate where a flash hazard exists in compliance with NEC 110-116. Labels shall be submitted for approval prior to application. Labels shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.04 SHORT-CIRCUIT ANALYSIS AND COORDINATION STUDY

A. Scope of Services:
   1. Provide a current and complete short-circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the electrical distribution system, including all feeder breakers 100A rating or higher.
   2. The System Coordination and Short-Circuit Analysis Study shall be performed by Electrotest Incorporated (ETI), or equal.

B. Submittals:
   1. The studies shall be submitted to the Architect prior to granting final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.

C. Short-Circuit Study:
   1. The study shall be in accordance with applicable ANSI and IEEE Standards.
   2. The study input data shall include the utility company's short-circuit single-and three-phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.
   3. Short-circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, distribution switchboard, panelboard, and other significant locations through the system.

D. Equipment Evaluation Study:
   1. An equipment evaluation study shall be performed to determine the adequacy of circuit breakers, controllers, surge arresters, switches, and fuses by tabulating and comparing the short-circuit ratings of these devices with the available fault currents. Any problem areas or inadequacies in the equipment shall be promptly brought to the Architect and Engineer's attention.

E. Protective Device Coordination Study:
   1. A protective device coordination study shall be performed to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker and fuse trip characteristics and settings.
   2. The coordination study shall include all voltage classes of equipment and protective devices. The study shall encompass the low-voltage distribution system, including all feeder breakers 100A rating or higher. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.

3. The time-current characteristics of the specified protective devices shall be plotted on appropriate log-log paper. The plots shall include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low-voltage circuit breaker trip curves, and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents. All requirements of the current National Electrical Code shall be adhered to. Reasonable coordination intervals and separation of characteristics curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a complete system basis. Sufficient curves shall be used to clearly indicate the coordination achieved to each main breaker or fused device, each feeder breaker, and each primary protective device.
4. The selection and settings of the protective devices shall be provided separately in a tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. A tabulation of the recommended power fuse selection shall be provided for all fuses in the system. Discrepancies, problem areas, or inadequacies shall be promptly brought to the Architect's attention.

F. Study Report:
1. The results of the power system study shall be summarized in a final report. Five (5) bound copies of the final report shall be submitted to the Architect.
2. The report shall include the following sections:
   a. Description, purpose, basis, written scope, and a single-line diagram of the portion of the power system, which is included within the scope of study.
   b. Tabulations of circuit breaker, fuse, and other equipment ratings versus calculated short-circuit duties, and commentary regarding same.
   c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
   d. Fault current tabulations including a definition of terms and a guide for interpretation.
   e. Tabulation of appropriate tap settings for relay seal-in units.

PART 3 - EXECUTION

3.01 REFER TO SECTION 26 05 00 FOR DETAILS OF WORK UNDER THIS SECTION.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Electric Service: Contact the local electric utility company service planning representative and coordinate with and arrange with the utility company for electric service to the project, including finalization of service application (which was already initiated), as required. Furnish and install all materials and labor necessary for complete installation as noted on drawings. Submit shop drawings and obtain approval from the utility company prior to fabrication. Also provide and install temporary power as required for construction operations.

B. Excavate and trench as necessary for the electrical installation, and when the work has been installed, inspected and approved, backfill all excavations with clean earth from excavation, or imported sandy soil in maximum 8" (eight-inch) layers, moisten and machine tamp to 95% compaction, and restore the ground and/or paving or floor surfaces to their original condition.

C. Switchboard and Distribution Panels Installation: Provide mounting channels for grouting into floor. Channels shall be properly drilled to receive the switchboard placed flush in floor, leveled and secured in place prior to pouring of floor, of length as required for switchboard. Bolt or weld switchboard to channels.

D. Motor Connections:
   1. Install motor circuits complete for all motors by other trades
   2. Furnish and install all disconnect switches, outlet boxes, etc., as required by code.
   3. All motor and temperature control low voltage wiring shall be installed and connected by Division 23 Section of specifications, unless otherwise indicated on electrical drawings.

3.03 TESTS

A. Testing and Inspection: See Section 26 08 00 - Testing.

END OF SECTION

SECTION 26 27 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work included in this Section: All materials, labor, equipment, services, and incidentals necessary to install the electrical work as shown on the drawings and as specified hereinafter, including but not limited to the work listed below:
   1. Raceways, feeders, branch circuit wiring, wiring devices, safety switches and connections to all equipment requiring electric service.

B. Any other electrical work as might reasonably be implied as required, even though not specifically mentioned herein or shown on the drawings.

C. All work shall comply with Section 26 05 00.

1.02 RELATED WORK

A. Division 09 - Finishes

B. Division 23 - Motors and Mechanical Equipment Installation

1.03 SUBMITTALS

A. Comply with the provisions of Section 26 05 00.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to Section 26 05 00, Basic Electrical Requirements, Part 2 - Products.

B. List of Equipment Manufacturers:

Conduit and Conduit Fittings

Allied Tube and Conduit, Wester Tube and Conduit, LTV Steel Tubular, National Electric Products, AFC, Republic Steel Corporation, Rome Cable Corporation, United States Steel Corporation, Killark Electric Manufacting Company, Raco, VAW Aluminum Company, Bridgeport, Steel City, Thomas & Betts, Carlon, O.Z. Gedney, Appleton, Regal.

Wire and Cable (600V)

American Wire Company, General Wire and Cable Corporation, Okonite Company, Rome Cable Corporation, Cerrowire, American Insulated Wire, AFC Cable Systems, Essex, Simplex Wire and Cable Company, Southwire.

Solderless Lugs and Grounding Connections

Burndy Engineering Company Inc, O.Z. Gedney Company Inc, Penn Union Electric Corporation, Thomas and Betts Company Inc.

Pull Boxes, Gutters, Special Cabinets

Square D Company, Columbia Electric Manufacturing Company, General Electric Company, Westinghouse Electric Corporation, Circle Awalt.

Outlet Boxes

Appleton Electric Company, Killark Electric Manufacturing Company, Lew Electric Fittings Company, National Electric Products Corporation, Raco, Steel City Electric Company, Carlon, Bowers.

Floor Boxes

Steel City Electric Company, Hubbell Inc, RCI, Walker.

Wiring Devices

Leviton, Arrow-Hart, Cooper, Hubbell, Lutron, Bryant.

Conduit Racks, Hangers

General Electric Company, Killark Electric Manufacturing Company, Caddy, National Electric Products Corporation, Republic Steel Corporation, Rome Cable Corporation, United States Steel Corporation, VAW Aluminum Company, Superstrut, B-Line.

Safety Switches (Disconnect and Fusible)

Square D Company, Cutler Hammer Inc, General Electric Company, Westinghouse Electric Corporation.

Fuses

Bussman Manufacturing Company, Chase-Shawmut Company.

Firestopping

3M, Nelson.

2.02 MATERIALS

A. Raceways: Only the raceways specified below shall be utilized on this project. Substitutions shall be pre-approved in writing. All bare conduit ends (stub-ups or stub-outs) shall be provided with bushed ends or manufactured insulated throat connectors:
   1. Rigid Type - hot dip galvanized or sherardized steel, use on all exterior locations, below grade or in concrete slab, and to 18" on either side of structural expansion joints in floor slabs (see item 18 below), with completely watertight, threaded fittings throughout. Compression fittings are not acceptable.
      a. All rigid steel conduit couplings and elbows in soil or concrete or under membrane to be ½ lap wrapped with Scotch #50 tape and threaded ends coated with T&B #S.C.40 rust inhibitor prior to installation of couplings.
      b. ½ lap wrapp all rigid steel conduit stub-ups from slab or grade to 6" above finished grade level with Scotch #50 tape.
   2. In lieu of rigid steel conduit for power and control raceways and branch circuit conduits in soil or concrete slabs, "Schedule 40" PVC with Schedule 80 PVC conduit elbows and stub-ups may be used with code size (minimum No. 12) ground wire. A “stub-up” is considered to terminate 6" above the finished surface.
      a. Schedule 80 PVC conduit shall be used in all concrete footings or foundations and to 18" of either side of footings or foundation walls.
      b. Schedule 80 PVC conduit shall be used in all concrete masonry unit (CMU) walls or columns.
      c. All conduit runs in concrete floor slabs (where allowed) shall be installed to comply with all applicable California Building Code and structural codes to maintain the structural integrity of the floor slab. Where conflicts occur, alternate routing shall be provided at no additional cost to the Owner.
      d. Where schedule 80 PVC is coupled to schedule 40 or other raceways with differing interior dimensions, each end shall be reamed with a reaming tool to reduce the edge profile for protection of the passing conductors during the pull.
   3. Intermediate metal conduit may be used in all exposed interior locations, except that electrical metallic tubing may be used in some locations as noted below. Utilize steel compression type fittings for all exposed conduit runs, unless otherwise noted. Cast fittings are unacceptable.
   4. Electrical metallic tubing shall be used exposed in interior electrical and mechanical rooms, in interior unfinished spaces, and in interior concealed and furred spaces, made up with steel watertight or steel set screw type fittings and couplings. EMT shall not be used in under-building crawl spaces or other areas subject to moisture. Set screws shall have hardened points. Cast fittings are unacceptable.
   5. Surface mounted rectangular steel raceways and boxes; use for all surface mounted installations, unless otherwise noted (all catalog numbers listed are Wiremold - equals allowed) – color Ivory, unless otherwise noted;

a. #V500 for branch power runs on ceilings and walls (used with V500 series straps, elbows, connectors and V5000 series low profile boxes and covers).
b. #2000 or 2400 low profile for larger power run requirements on ceiling or walls (used with V2000 series straps, elbows, connectors and low profile boxes and covers).
c. #2400D for dual service power and tel/data run requirements (used with divided V2400 boxes and covers).

6. Surface mounted rectangular non-metallic dual service raceways; Wiremold #5400 (Ivory) or equal with all required compatible activation covers, bezels, inserts, and blank plates for a complete installation. Refer to drawings for outlet quantities in raceway and feed points. All raceway fed flush from rear with horizontal j-boxes, unless otherwise noted.
7. Use flexible conduit for all motor, transformer and recessed fixture connections, minimum ½"; "Seal tite" type used outdoors and in all wet locations, provide with code size (minimum No. 12) bare ground wire in all flexible conduit.
8. All conduit cuts (factory or field cut) shall be perfectly square to the length of the conduit and cut ends shall be reamed with a reaming tool to provide a smooth edge to the passing conductors and to remove all burs and scrapes. Use of a hand file is not acceptable.
9. All electrical raceways shall be installed concealed, unless otherwise noted. Cut and patch to facilitate such installation to match adjacent and original finish. All exposed conduits, where required, shall be installed parallel to building members.
10. Where existing conditions preclude the installation of EMT in existing walls to remain, provide and install cut-in type boxes and "fish" flexible MC or flex conduit and wire through existing walls to remain, unless shown otherwise on plans.
11. Fasten conduits securely to boxes with locknuts and bushings to provide good electrical continuity.
12. Provide chrome escutcheon plates at all exposed wall, ceiling and floor conduit penetrations.
13. Support individual suspended conduits with heavy malleable strap or rod hangers; supports for ½ inch or 3/4 inch conduit placed on maximum 7-foot centers; maximum 10-foot centers on conduits 1 inch or larger.
14. Support multiple conduit runs from Kindorf B907 channels with C-105 and C-106 straps.
15. Conduit bends - long radius.
16. Flash conduits through roof, using approved roof jack; coordinate with General Contractor.
17. To facilitate pulling of feeder conductors, install junction boxes as shown or required.
18. All empty conduits on the project shall be provided with a nylon pull rope to allow pulling of future conductors intended for the specific raceway. Provide plastic wire-tie style nameplate tags on each end of pull rope with printed identification of conduit use and the location of the opposite end of the rope. Pull ropes for telephone and cable tv service conduits shall meet the respective utility company requirements.
19. Where conduits pass through structural expansion joints in floor slab, rigid galvanized conduit shall be used 18" on either side of joint, complete with Appleton expansion couplings and bonding jumpers, or equal. All above grade expansion joint crossings shall also utilize expansion joint couplings or flex conduit transitions as required for each particular installation. Installed condition

shall allow for a minimum deflection of raceway and wire (in any direction) equal to the structural expansion joint dimension (building to building). No solid conduits shall be allowed to cross expansion joints without proper provisions for building and seismic movement.

20. Minimum cover of conduits in ground outside of building - 36 inches, unless otherwise noted.

B. Outlet Boxes and Junction Boxes. Verify all backbox requirements with devices to be installed prior to rough-in.
   1. One piece steel knockout type drawn boxes, unless otherwise noted, sized as required for conditions at each outlet or as noted.
   2. Flush-mounted boxes equipped with galvanized steel raised covers for device mounting flush with finished surface. Provide extension rings as required on all acoustical or additional wall treatment areas to bring top of cover flush with finished surface (coordinate with architectural drawings). Devices shall be capable of being tightly mounted to boxes without distorting or bending device or mounting hardware.
   3. Boxes for fixture outlets: 4-inch octagon or larger as required, or as noted.
   4. Switch and receptacle outlets - not smaller than 4-inch-square in furred walls, with raised cover for single device; ganged where required.
   5. Outlet and switch boxes for wet locations, cast aluminum FS or FD type with cast aluminum gasketed spring lid cover. Weatherproof “Bell” type boxes are not acceptable.
   6. All connectors from conduit to junction or outlet boxes shall have insulated throats. Connectors shall be manufactured with insulated throats as integral part. Insertable insulated throats are unacceptable.
   7. Outlet boxes for cable TV, telephone, 4" square or larger as required or noted, multi-ganged for telephone, data, and other services where indicated on the drawings.
   8. Conduit Bodies: Malleable iron type, with lubricated spring steel clips over edge of conduit body, O-Z/Gedney type EW, or equal.
   9. Floor Boxes:
      a. Classification and Use: Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and Canadian Standard C22.2 and shall bear the appropriate label. Floor boxes shall conform to the standard set in the National Electrical Code. Multi-compartment boxes shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
      b. Floor boxes shall provide flush or recessed device outlets that will not obstruct the floor area. Refer to Drawings for size and types. This specification covers concrete and wood frame floor applications with Wiremold 800, 860 and 880 and RFB Series boxes.
      c. Cast-Iron Boxes: Box interior and exterior shall be painted. Boxes shall be available in 1,2, and 3 gang configurations. Boxes shall also be available in deep and shallow versions. Box shall provide 1-3/4 inches of pre-pour adjustment and 1/2 inch of post-pour adjustment.
      d. Steel Boxes: Boxes shall be manufactured from stamped steel and formed. Boxes shall be available in 1,2, and 3 gang configurations. Boxes shall also be available in deep and shallow versions. All stamped steel versions shall

provide 1-3/4 inches of pre-pour adjustment and 1/2 inch of post-pour adjustment.

e. Nonmetallic Multi-service Floor Boxes: Boxes shall be manufactured through the use of injection molded Geon M3900 PVC material. The box shall be rectangular in shape. Boxes shall allow for ganging of boxes together through a dovetail interlocking mechanism. Knockouts shall be provided on the side walls of each box to provide for pass-through capability between each gang. Boxes shall also have concrete depth markings on the exterior of the box to indicate box depth at the time of the pour. Boxes shall also provide graduated cubic inch markings on the interior of the box to indicate volume capacity at the appropriate box depth. Box shall accommodate concrete depths from 3-1/2 inches minimum to 6 inches maximum.
   1) Floor boxes shall provide (2) 1-1/4 inch conduit openings to feed cabling to the box. Boxes shall provide the means to reduce this opening to fit 1 inch, 3/4 inch and 1/2 inch conduit sizes. Box shall be equipped with a high impact mudcap to protect the box from damage and prevent concrete entry during the pour and debris entry after the pour. Box shall also provide ratchet teeth along interior box walls to attach cover. Box shall include internal spacer to prevent deformation of the box sidewalls when high temperature additives are used in the concrete pour.
   2) Adjusting rings shall be used to attach flanges and covers to the floor box body. Adjusting ring shall have ratchet teeth to align with the teeth on box wall to connect box body without the use of adhesive or mechanical fasteners. Adjusting ring shall provide for 10 degrees of adjustment after concrete pour to adjust to various concrete conditions and floor finishes. Provide brass inserts to mount finish flanges to box body. Adjusting ring shall also provide for grounding locations using brass inserts.
   3) Adjusting ring shall provide the ability to accept a modular connectivity system. Modular communication inserts shall snap directly into the adjusting ring openings. Adjusting ring shall provide a fiber storage loop to maintain proper fiber optic bend radius control and excess fiber storage. Each adjusting ring shall except up to six connectivity activation locations. Adjusting ring shall allow modular connectivity inserts to be mounted recessed and protected when not in use.

f. Covers and Flanges:
   1) Floor box options shall accept aluminum, brass and nonmetallic cover plates and flanges.
   2) Flanges shall be available in one-, two-, and three-gang applications. Each flange shall provide 1/2 inches of adjustment to accommodate various floor coverings and concrete depths.
   3) Flanges shall accommodate connectivity outlets and modular inserts.
   4) Modular inserts shall snap directly into each flange using a mounting bezel.

g. Multi-Compartment Boxes:
   1) Boxes shall be fully adjustable, providing a maximum of 1-7/8 (RFB4) 2” (RFB9/RFB11) inch pre-pour adjustment, and a maximum of 3/4 inch post-pour adjustment.

2) Boxes shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate connectivity and AV outlets with modular inserts.
3) The box shall provide ¾", 1" and 1 ¼" conduit size openings with 2" KO for larger size boxes.
4) Cover shall be cast aluminum. Lid shall be offered with solid, flush surface for tile, wood or terrazzo and an insert option for carpet inlay.
5) Cover options shall support loads from 390LBS to 3000LBS
6) Use cast iron boxes for on-grade applications (RFB4-CI-1). Stamped steel allowed for above grade applications (RFB-4 and RFB-4DB).

10. Pull boxes: All site pull boxes shall be flush in-ground concrete, with engraved covers identifying service use (i.e. electrical, communications, etc.). Boxes shall be Nema 250, Type 6, outside flanged, with recessed cover for flush mounting, by Christy or equal, with required depth to provide box and conduit depths shown or required.
    a. Provide concrete covers for all boxes in planted or paved areas (up to available concrete cover size).
    b. Provide galvanized steel covers for all larger boxes (when concrete is not available), or in traffic areas. No cast iron covers.
    c. Provide bolted covers and slab bottoms (with grouted perimeter) or vault type boxes for all electrical distribution and signal system pull boxes used for site distribution, to prevent rodent entry. No colar type boxes with dirt or gravel bottoms
    d. Provide drain hole at bottom of all vault type boxes, with loose aggregate base below, for proper drainage.
    e. All covers to be completely flush with finished adjacent surfaces.
    f. Provide galvanized steel H20 rated covers and installation of box rated for H20 in all traffic areas.
    g. Provide pullboxes per utility company specifications for all electrical primary and secondary services and for cable TV and telephone service runs. Verify exact size and type prior to order with each utility company.

C. Wire and Cable (line voltage and signal systems):
1. 600-volt class where used for or run with line voltage power wiring, insulation color coded, minimum No. 12 awg for power branch circuits, No. 14 for power control circuits, and wiring size and type as directed by signal system manufacturer for each signal system.
2. All conductors shall be copper.
3. Size and insulation type:
    a. Standard locations: #12 to #1 AWG: THWN for wet locations and THHN for dry locations. #1/0 through #4/0 AWG: XHHW (55 Mils). 250MCM and larger: XHHW (65 Mils). All wire sizes used shall be based on a 75 degree insulation rating, unless specifically used with 90 degree rated breakers and devices.
    b. All wiring (power and signal) installed underground between buildings, or in wet or damp locations, shall be outside listed and rated for wet locations.
    c. High temperature and non-standard locations: Provide wire type and insulation category suitable for area of use as defined in NEC table 310-13.
4. Conductors No. 8 and larger and as otherwise noted on drawings shall be stranded. Conductors No. 10 and smaller shall be solid.

5. Provide signal system wiring for each system to meet the system manufacturers requirements and recommendations for each device or equipment type. Signal wiring systems shall be provided with shielding and/or insulation type and cable quantities as directed by the manufacturer, and meet all NEC requirements for locations used.
6. Install all wiring branch circuits and feeders (low voltage and line voltage) in conduit unless noted otherwise in the drawings. Contractor shall mandrel all feeders and pass a "sock" (or utilize other suitable means) through each raceway prior to pull to remove all water and construction debris. All raceways shall be completely clear of any obstructions or debris and all cut ends shall be reamed, prior to pull. Utilize pulling compound on all runs to insure minimum friction and pulling tension.
7. Megger test all feeders prior to energizing. See section 26 08 00 for additional information.
8. Approximately balance branch circuits about the neutral conductors in panels.
9. Connections to devices from "thru-feed" branch circuit conductors to be made with pigtails, with no interruption of the branch circuit conductors.
10. Neutral conductor identified by white outer braid, with different tracers of "EZ" numbering tags used where more than one neutral conductor is contained in a single raceway.
11. Neatly arrange and "marlin" wires in panels and distribution panelboards with "T and B Ty-rap" or approved equal plastic type strapping.
12. All wire and cable shall bear the Underwriters' Label, brought to the job in unbroken packages; wire color-coded as follows:

Voltage	Phasing	A	B	C	N
120/208	3PH4W	Black	Red	Blue	White
2083PH	3W	Black	Red	Blue	--

13. The equipment grounding conductor shall be insulated copper; where it is insulated, the insulation shall be colored green.
14. Label each wire of each electrical system in each pull box, junction box, outlet box, terminal cabinet, and panelboard in which it appears with "EZ" numbering tags indicating the connected circuit numbers.
15. Provide permanently affixed adhesive labels with machine printed lettering (min. 1/8" high) at junction boxes serving fixtures that are supplied by (2) electrical sources (i.e. normal and emergency lighting). Label to read "CAUTION - This light fixture is powered by (2) separate sources. The normal power source breaker and the emergency power source breaker must be turned off before servicing this light fixture."
16. Install feeder cables in one continuous section unless splices are approved by Architect. Exercise care in pulling to avoid damage or disarrangement of conductors, using approved grips. No cable shall be bent to smaller radius than the spool on which it was delivered from the manufacturer. Color code feeder cables at terminals. Provide identifying linen tags in each pullbox.
17. Metal-clad cable, (MC) may be used in lieu of conduit and wire at concealed locations for final branch runs to devices on same circuit only. MC cable may not be used for multi-circuit branch circuit homeruns or feeders. Provide conduit and wire homeruns and feeders.
    a. The conductors shall be soft drawn annealed copper, solid or stranded as stated above. Insulation shall be type THHN. Conductors shall be cabled with fillers, taped wrapped with overall seamless corrugated aluminum sheath.

b. Cables shall be 3 or 4 conductor type with parity sized ground wire.

D. Switches: Model numbers are Hubbell, color to be selected by architect, unless otherwise noted. All switches to utilize screw terminals for wire connections - no plug-in terminations:
1. Single Pole - No. HBL1221
2. Two Pole - No. HBL1222
3. Three Way - No. HBL1223
4. Momentary contact - No. HBL1557
5. Momentary contact Keyed - No. HBL1556L
6. Keyed, - No. HBL1221L
7. Pilot Light (on with load on) - Hubbell No. 1221-PLC
8. Motor Rated Double Pole (30A) - Hubbell No. 7832
9. Motor Rated Three Pole (30A) - Hubbell No. 7810.
10. Low voltage Data line switches - Refer to lighting control system (for compatability)

E. Receptacles: Mounting straps and contacts shall be one piece design, constructed of minimum .050" solid brass. Base shall be high strength, heat resistant, glass reinforced nylon. Device shall accept up to #10 wire, side or back wired with screw terminals - no plug-in terminations. Hubbell, Leviton, Pass & Seymore, or equal. Color to be selected by architect, unless otherwise noted. Numbers listed below are Hubbell:
1. 15A 3PG 125 volt duplex - No. HBL5262
2. 20A 3PG 125 volt duplex - No. HBL5362
3. 20A 3PG 125 volt ground fault interrupter receptacle; GFI receptacles shall conform to the 2006 UL requirements to a) interrupt power to the unit in the event of internal failure, or b) provide an audible or visual indication of internal failure of the GFI; No. GF20 or equal. Through wiring to down stream GFI designated receptacles is not acceptable.
4. GFI Module (blank face), no indicator light, 20A – No. GFBF20 or equal.
5. All receptacles located in exterior or wet locations shall be corrosion resistant with UV stabalized body.

F. Plates: Leviton, or equal, except as noted:
1. The color of all faceplates shall match the color of the devices installed under/in the faceplate, except as specifically noted otherwise.
2. For flush outlet boxes, for switches, and receptacles: nylon, color to be selected by architect, unless otherwise noted.
3. Plates for surface-mounted outlets: galvanized steel unless otherwise noted.
4. Weatherproof duplex receptacle plates for exterior locations with ground fault interrupter receptacles in type FS or FD boxes – Appleton #FSK-1VDR or compatible equal. Verify cover compatibility with box type and device installed.
5. Weatherproof "in-use" cover, vertical or horizontal mount, for exterior with GFCI receptacles. Die-cast metal alloy, Taymack MX series or equal with openings to match installed devices.
6. Locking plates for duplex receptacles where noted; Pass & Seymour #WP26-L (non weather proof).
7. Locking plates for duplex exterior GFCI receptacles (or in wet or damp locations); Heavy duty cast aluminum flush cover with locking latch and key, Pass & Seymour #4600 with appropriate mounting plate for type of device installed.

Coordinate backbox requirements and finished wall trim-out with wall installer prior to rough-in to insure an adequate and neat trim appearance upon completion.

8. Plates for flush telephone / data boxes: white nylon or as otherwise directed - provide and install at each telephone /data outlet plate to match duplex power outlet plate, for jack installation by others. Where the power and telephone / data outlet boxes are shared the plate shall be continuous in multi-gang locations. See drawings.

G. Equipment Disconnects: All disconnects shall be located to allow proper code required clearance in each area. Locations shown on drawings are diagrammatic only. The contractor shall coordinate exact locations in the field (with other trades) prior to rough-in to insure proper clearances.

1. Motor Disconnect Switches and Safety Switches: General Electric Company Heavy Duty Type "THD", cover interlocked with operating handle so that cover cannot be opened with switch in closed position and switch cannot be closed with cover in open position. 240V or 480V rating, single or multi-pole as required or as noted on drawings, in Nema 1 enclosure indoors or Nema 3R enclosure outdoors unless otherwise noted. Provide dual element motor circuit fuses sized as recommended by equipment manufacturer (for final equipment actually installed).
2. Code required disconnects: Provide a local disconnect in addition to the branch circuit protection device for all equipment as required by code (whether shown or not). Disconnects shall consist of a motor rated switch (or disconnect) for all motor loads less than 3/4HP or other suitable disconnect sized to match branch circuit conductors and load current of equipment, with number of poles as required.

H. Lugs and Connectors: Thomas and Betts "lock-tite", for No. 4 and larger wire; 3M "Scotchlock" fixed spring screw-on type wire connectors with insulator for No. 6 and smaller wire.

1. All splices shall be made up with screw-on type connectors - no plug-in or push-in style connectors acceptable. Wires shall be solidly twisted together with electricians pliers before screw-on connector is installed to ensure a proper connection in the event of wire nut failure. No exceptions.
2. Connectors listed or labeled for “no wire twisting required” are not an acceptable substitute for actual wire twisting.
3. Utilize porcelain type connectors in all high temperature environments (above 105 degrees Celsius).

I. Splice Insulation: "Scotch" electrical tape with vinyl plastic backing or rubber tape with protective friction tape for interior work.

1. Splices in electrical cables of 600 volt insulation class in underground system duct shall be made only in accessible locations such as pullboxes, light pole handholes, etc., using a compression connector on the conductor and by insulating and waterproofing (for exterior and underground locations) by one of the following methods:
   a. Cast type splice insulation shall be provided by means of a molded casting process employing a thermosetting epoxy resin insulating material which shall be applied by a gravity poured method or by a pressure injected method. The component materials of the resin insulation shall be in a packaged form ready

for convenient mixing after removing from the package. Do not allow the cables to be removed until after the splicing material has completely set.

b. Gravity poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for the cables to be applied. When the mold is in place around the joined conductors, the resin mix shall be prepared and poured into the mold. Do not allow cables to be moved until after the splicing materials have completely set.

J. Identification: Refer to Section 26 05 00.

K. Firestopping: as manufactured by 3M Fire Protection Products or equal.

1. Fire-rated and smoke barrier construction: Maintain barrier and structural floor fire and smoke resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound vibration absorption, an at other construction gaps.
2. Systems or devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetration type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall penetrations. Systems or devices must be asbestos free.

PART 3 - EXECUTION

3.01 REFER TO BASIC ELECTRICAL REQUIREMENTS - SECTION 26 05 00 FOR WORK UNDER THIS SECTION.

3.02 TESTS

A. Testing and Inspection: See Section 26 08 00 - Testing.

END OF SECTION

SECTION 26 32 14

EMERGENCY ELECTRIC GENERATOR

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide a complete Emergency Generator plus accessories, as noted herein and as indicated on the Drawings.

1.02 SUBMITTALS

A. Refer to Section 26 05 00 and 01 33 00 for procedure.

B. Tests and Reports (Test Requirements are detailed in Paragraph 1.4 below).
   1. Provide certified test reports of the following:
      a. Factory tests.
      b. Field Tests: Test reports shall include dates performed, method of testing, test results, test interpretation and recommended action.
   2. Shop Drawings and Product Data
      a. The following list includes the required Shop Drawing information that shall be submitted for the generator:
         1) Physical dimensions and weights (generator and enclosure).
         2) Brake horsepower of engine.
         3) Fuel consumption.
         4) Cooling requirements.
         5) Noise db level.
         6) Electrical characteristics of generator, voltage regulator, and battery charger.
         7) Load graphs.
         8) Control panel.
         9) Elevation.
         10) Wiring and control diagrams.
         11) Fuel tank, including fill-point.
         12) Engine and generator details, including governor.
         13) Location of available parts and service.
         14) Confirmation that engine meets the latest EPA Tier Exhaust Emission Compliance Statement, and that the engine complies with the required values for the local Air Quality Management District standards (to be verified at the time of procurement). Values shall be at engine full standby rating.

C. Maintenance and operating instruction manuals, four bound copies, including approved shop Drawings, parts list, list of recommended spare parts, sources of purchase and similar information.

1.03 GUARANTEE

A. Provide a written guarantee against all defects in materials and application, which prevent proper functioning for one (1) year from date of acceptance of the project.

1.04 TESTS

A. Certified copies of factory test giving guaranteed performance characteristics to meet the Specifications should be furnished by the Manufacturer. The unit shall be tested at the Manufacturer's plant for performance of all functions including a 2-hour full load test or until all temperatures have been stabilized for at least 30 minutes.

B. The Manufacturer shall have field tests made of the generator and wiring systems in place by a qualified factory technician. The complete engine generator set with all of its appurtenances shall be tested after installation for all functions, including a 2-hour full load test with full-rated reactive (0.8pf) load bank. The Manufacturer shall supply all equipment necessary for the tests.

1.05 FUNCTION

A. The emergency generator shall function to start automatically and immediately upon power failure of the normal power supply, assume full load within ten (10) seconds and automatically switch into the emergency power system. The unit shall be automatically removed from the line upon resumption of normal power and stopped five (5) minutes later.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:
   1. Provide and install a complete emergency power system, including power plant powered by diesel engine driven generator and operated by means of a signal from any automatic transfer switch. The system shall be complete, tested and meet all the functional requirements of a fully automatic emergency power source serving full load power stabilized at rated voltage and frequency within three seconds after normal power source failure.
   2. The generator (with belly tank) shall be capable of being installed within the space available. See site plan.
   3. The diesel engine generating set shall be fully automatic and shall be complete with starting and control equipment, critical grade muffler, skid- mounted batteries, weatherproof sound attenuated enclosure, battery charger, and other equipment necessary to provide a complete, fully automatic system.
   4. Arrange for the services of a factory erection Engineer for checking installation, making specified and all other necessary tests, making initial start, instructing operating personnel in operating unit through all of its functions to ensure that the unit is performing in accordance with the intentions of the Specifications.
   5. Manufacturers: Generac, Cummins-Onan, Kohler, Caterpillar, or equal.

6. The entire installation shall meet all the requirements of the California Electrical Code, California Fire Code, Union City Building and Fire Department requirements, and the local Air Quality District requirements.
7. Power Plant:
   a. Rating shall be based on continuous standby power rating of the generator and with capabilities to carry 100% full load without damage to the engine, generator or components, and with capabilities for starting the largest motor scheduled for the standby power system while carrying full connected load at an altitude of 1500 feet above sea level. See plans for KW and voltage rating (0.8pf rated).
      1) Voltage regulation shall be +/-0.5% for any constant load between no load and rated load.
      2) Frequency regulation shall be isochronous from steady state no load to steady state rated load.
      3) The diesel engine generator set shall be capable of single step load pick up of 100% nameplate KW and power factor, less applicable derating factors, with the engine-generator set at rated operating temperature.
      4) Under motor starting conditions the generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified KVA load at near zero power factor applied to the generator set.
      5) Maximum transient voltage dip shall not exceed 35 percent below rated on application of the single largest surge load step.
      6) Provide unit and all accessories on a common base, capable of mounting on a belly fuel tank unit, with a sound attenuated, Nema 3R outdoor enclosure.
      7) Unit shall be capable of being installed in the exterior location shown on the drawings, including 3 feet clearance on all sides.
      8) Provide minimum 18" flexible Section in all electrical, fuel and exhaust lines at connection to power plant.
      9) Provide flexible steel disc coupling to engine-generator.
      10) Provide lifting brackets.
      11) Provide vibration isolators, spring type, adjustable to account for pad settlement over time, with seismic zone 4 restraints. 2” deflection spring isolators within the enclosure shall support the generator.
      12) Provide restraint brackets to prevent vertical or horizontal movement of over 1/2" during seismic shock for generator set, day tank and muffler.
8. Engine:
   a. The engine shall be 4-cycle design, 6 cylinders, water-cooled; series turbo charged with after cool, having no inherent unbalanced reciprocating forces. Operating speed shall be 1800 RPM. Minimum displacement of 7.5 liters.
   b. Starting by battery-driven starter. Include cranking sequencer, which shall give three (3) start attempts before locking out over-cranking protection.
   c. Governor shall be isochronous electronic as required to maintain generated frequency at 60 Hz. at 75% full load within a steady state band-width of (+/-) 0.25%. Frequency shall not vary over 3% from no load to full load. Governors using engine crankcase lube oil will not be acceptable. Governor shall be type EFC, Electronic Isochronous.
   d. Provide fuel and lubrication systems for diesel engine, complete with replacement element type air cleaner; primary and secondary fuel filter and oil filter; full pressure lubrication system with positive displacement lube oil pump and spring-loaded bypass valve; lube oil cooler; engine driven fuel

transfer pump. Provide silencer mounting for housing, and tail pipe and rain cap kit.

e. Provide a cooling system with sufficient capacity for cooling engine when generator is delivering 100% full load for four hours at ambient of 40 degrees C at an altitude of 350 feet. Include water-circulating pump and thermostatic valve to maintain recommended engine temperature; radiator with drain and air vent and fan with protective guard; jacket water corrosion resistant heating elements (1 unit at 1500W 120V). Radiator shall be filled with antifreeze solution of strength as recommended by Manufacturer.

f. The exhaust system shall consist of a Nelson critical grade silencer. All areas within 24 inches of the silencer shall be covered with 6 lb. density mineral wool. All piping shall be schedule 40 black pipe.

1) The exhaust system shall consist of black standard weight iron pipe from the engine with 18" flexible connection between engine and muffler. The exhaust muffler shall be critical grade, of 3-chamber construction with high degree silencing materials and shall be unit installed. Provide silencer mounting for housing, and tail pipe with rain cap.

2) Provide a unit-mounted battery for engine start, 24-volt DC with a capacity of not less than 160-ampere hours at 20-hour rate. The battery shall also be sized for six starts of 30-second cranking duration each, with ambient 15 degree F, mounted on earthquake-proof tray on pad with all necessary battery cables, hydrometer and enclosure-mounted voltage-regulated battery charger in Nema 1 enclosure with float, taper, and equalize charge settings and with DC voltmeter, DC ammeter and circuit for low voltage alarm. Battery shall be lead-acid type.

3) Auxiliary switches for over-speed trip and automatic over-speed shut down at a speed 10% greater than the normal specified operating RPM. The engine shall shut down on over-speed, low oil pressure, high oil temperature and high water temperature by means of auxiliary switches, actuating signal lights and alarms.

4) Temporary batteries may be used for testing, but new, unused batteries shall be furnished after final testing is complete and before acceptance. New batteries shall be used for one generator start to demonstrate adequacy of final battery installation.

5) Engine exhaust emissions shall meet the latest EPA Tier Exhaust Emission Compliance Statement, and the engine shall comply with the values for the local Air Quality Management District standards (to be verified at the time of procurement). Values shall be at engine full standby rating.

9. Generator:

a. 120/208-volt, 3-phase, 60 Hz., 4-wire rated at 0.8 power factor continuous standby service, complying with NEMA standards.

b. Brushless, balanced 4-pole revolving field type with rotating rectifier exciter mounted on end of shaft, single ball bearing support to starter housing, rotor connected by semi-flexible steel disc coupling to engine flywheel to assure permanent alignment free of injurious tensional vibrations at speeds up to 125% of synchronous. Rated for 105 degrees Centigrade rise.

c. Generator insulation shall be in accordance with latest NEMA standards using minimum Class H materials. All insulation system components shall meet NEMA MG1 temperature rise limits for Class H insulation system.

Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees centigrade.

d. A permanent magnet generator (PMG) shall provide excitation power for immunity to voltage distortion caused by non-linear loads. The PMG shall sustain excitation power for optimum motor starting and to sustain short circuit current at approximately 300% of rated current for not more than 10 seconds.

e. Voltage regulator of static solid state design to give (+/-) 2% regulation from no--oad to full load; instantaneous voltage dip less than 20% of rated when full load at rated power factor suddenly applied; and recovery to stable operation of voltage within 1% of rated within four seconds. The voltage regulator shall be of the asynchronous pulse width modulated type and shall be insensitive to severe load-induced waveshape distortion from SCR or thyristor circuits such as those used in UPS and motor speed control equipment. Manual adjustment of (+/-) 5% of normal to be included by a lockable device or screwdriver slot in rheostat shaft. All voltage sensing shall be 3-phase.

1) The automatic voltage regulator shall be temperature compensated, solid-state design. The voltage regulator shall control build up of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include a torque-matching characteristic, which shall use differential rate of frequency change compensation to use the maximum available engine torque and provide optimal transient load response. Regulators, which use a straight line fixed volts per hertz characteristic, are not acceptable.

2) Shielding of generator, exciter and regulator to prevent radio frequency interference.

3) The generator, exciter, and voltage regulator shall be designed and manufactured by the engine-generator set Manufacturer so that the characteristics shall be matched to the torque wave of the engine to provide the fastest possible system recovery from transient load changes and to prevent engine stall during transient overload conditions.

10. Control Equipment:

a. Panel mounted with vibration isolators to plant frame. Top of panel shall not exceed 6'-0" above grade.

b. The generator set shall be provided with a microprocessor-based control system, which shall be designed, to provide automatic starting, monitoring and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set and remote monitoring and control as described in this Specification. The control panel shall be mounted on the generator set.

c. The control panel shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

d. The control panel shall be UL508 labeled, CSA282-M1989 certified and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight and the enclosure door shall be gasket. There shall be no exposed points in the control panel (with the door open) that operate in excess of 50 volts. The controls shall met or exceed the requirements of Mil-Std 461C part 9 and IEC Std 801.2, 801.3 and 801.5 for susceptibility, conducted and

radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.

e. The generator set mounted control panel shall include the following features and functions:
   1) Three position control switch labeled RUN/OFF/AUTO: In the RUN position the generator set shall automatically start and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
   2) Red “mushroom-head” push-button EMERGENCY STOP switch: Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.
   3) Push-button RESET switch: The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
   4) Push-button PANEL LAMP switch: Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed or after the switch is depressed a second time.
   5) Generator Set Metering: The generator set shall be provided with a metering set with the following features and functions:
      (a) 2.5-inch, 90? scale analog voltmeter, ammeter, frequency meter and kilowatt (KW) meter. These meters shall be provided with a phase select switch and an indicating lamp for upper and lower scale on the meters. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
      (b) Digital metering set, 0.5% accuracy, RMS type to indicate generator voltage, frequency, output current, output KW, KW-hours and power factor. Generator output voltage shall be available in line-to-line neutral voltages and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
      (c) Generator Set Alarm and Status Indication: The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel.

         (1) Low oil pressure (alarm)

         (2) Low oil pressure (shutdown)

         (3) Oil pressure sender failure (alarm)

         (4) Low engine temperature (alarm)

         (5) High engine temperature (alarm)

(6) High engine temperature (shutdown)

(7) Engine temperature sender failure (alarm)

(8) Low coolant level (alarm or shutdown--selectable)

(9) Fail to crank (shutdown)

(10) Over-crank (shutdown)

(11) Over-speed (shutdown)

(12) Low DC voltage (alarm)

(13) High DC voltage (alarm)

(14) Weak battery (alarm)

(15) Low fuel (alarm)

(16) High AC voltage (shutdown)

(17) Low AC voltage (shutdown)

(18) Under frequency (shutdown)

(19) Over current (warning)

(20) Over current (shutdown)

(21) Short circuit (shutdown)

(22) Ground fault (alarm)

(23) Under frequency (alarm)

(24) In addition, provisions hall be made for indication of two customer-specified alarm or shutdown conditions. The non-automatic indicating lamp shall be red and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

(d) Engine Status Information: The following information shall be available from a digital status panel on the generator set control:

(1) Engine oil pressure (psi or kPA)

(2) Engine coolant temperature (degrees F or C; both left and right bank temperature shall be indicated on V-block engines)

(3) Engine oil temperature (degrees F or C)

(4) Engine speed (rpm)

(5) Number of hours of operation (hours)

(6) Number of start attempts

(7) Battery voltage (DC volts)

(e) Generator Control Panel shall monitor the status of the Automatic Transfer Switch for:

(1) ATS Normal Position

(2) ATS Emergency Position

(f) The ATS status shall be displayed on the Generator Remote Annunciator.

6) Control Functions: The control system provided shall also include a cycle cranking system, which allows for user selected crank time, rest time and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each with 15-second rest periods between cranking periods.

7) The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode the alternator excitation system shall be disabled.

8) The control system shall include an engine governor control which functions to provide steady state frequency regulation as noted elsewhere in this Specification. The governor control shall include adjustments for gain; damping and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

9) The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

10) The control system shall include sender failure monitoring logic, which is capable of discriminating between failed senders or wiring components and an actual failure conditions.

11) Alternator Control Functions:The generator set shall include an automatic voltage regulator. The voltage regulator shall be immune from misoperation due to load-induced voltage waveform distortion. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include a torque-matching characteristic which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping and frequency roll-off. The regulator shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

(a) Controls shall be provided to monitor the output current of the generator set and initiate an alarm condition when total load on the generator set exceeds 110% of the rated current of the generator set on any phase for more than 5 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.

(b) Controls shall be provided to monitor the KW load on the generator set and initiate an alarm condition when total load on the generator set exceeds the generator set rating for a period in excess of 5 seconds.

(c) Controls shall include a load shed control to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

(d) An AC over/under voltage monitoring system shall be provided which initiates shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds or instantaneously when voltage exceeds 130%. Under voltage shall be indicated when the output voltage of the alternator is less than 85% for more than 10 seconds.

12) A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine starting the low voltage limit shall be disabled and if DC voltage drops to less than 14.4 for more than 2 seconds, a “weak battery” alarm shall be initiated.

13) The control system shall include a ground fault monitoring relay. The relay shall be adjustable from 100-1200 amps and include adjustable time delay of 0.1 to 10 seconds. The relay shall be for indication only and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set and provide relay which will function correctly in system as installed.

14) Control Interfaces for Remote Monitoring: All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

(a) Form ”C” dry common alarm contact set to indicate existence of any alarm or shutdown condition on the generator set.

(b) One set of contacts to indicate generator set is ready to load. The contracts shall operate when voltage and frequency are greater than 90% of normal condition.

(c) A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

(d) The control panel shall be provided with provisions for connection of remote monitoring equipment as described herein or shown on the drawings.

(e) Generator status shall be continually monitored by the building fire alarm system for generator running, trouble, and low fuel conditions. Provide (3) monitor inputs from the Fire Alarm System to the generator control panel to monitor running, trouble, and low fuel conditions. These points shall annunciate on the fire alarm annunciator.

11. Remote Indicator Panel: The remote annunciator panel shall be flush-mounted with micarta label reading "Engine Operator Conditions," and with the following devices:

a. Green pilot light with engraving to indicate "ENGINE RUNNING."

b. One audible alarm with silencing switch to indicate engine start failure for any of the following reasons:

1) High water temperature.
2) Low oil pressure.
3) Over-speed.
4) Over-crank.
5) Low battery voltage.
6) Low-level fuel alarm.

7) Remote indicator panel shall include an amber light indication for each of the following:
   (a) Control switch not in auto position.
   (b) Low water temperature.
   (c) ATS in normal position.
   (d) ATS in emergency position.
8) Each of the functions listed previously in Paragraphs 2. (a) through (f) shall be indicated by a separate red warning light and each warning light shall be so engraved.

c. Fuel System: The fuel system shall conform to NFPA 30 and 37 and the City Fire Department requirements. The fuel system shall be complete and shall consist of a dual filtering system, base-mounted fuel tank, and engine fuel pump. The engine shall start, operate, and stop on DF-2 fuel.
   1) Fuel Filtering System: The fuel filtering system shall consist of a strainer, located between the storage tank and the fuel transfer pump, and a duplex fuel filter, located between the engine fuel pump and the engine. The filtering system shall be capable of removing from the fuel system flakes, dirt, metallic chips, carbon, water, or other foreign matter which would be harmful to the engine. The filtering system shall be easily accessible for quick-and-easy replacement of the filter element and cleaning of the strainer. Components of the filtering system shall be the standard products of the engine manufacturers.
   2) Fuel Tank: The fuel tank shall be skid mounted under the engine, and shall be capable of providing an immediate fuel supply to the engine fuel pump. The tank shall be provided with a flexible tubing suction line to the engine, an excess fuel return line from the engine to the tank, a fuel gauge, a vent, a drain pipe, and high and low-level float switches for activating the low-level alarms. Fuel tank capacity shall be min. 194 gallons.
      (a) The tank shall be a full double wall, U.L. listed design and shall be factory tested in accordance with the requirements of U.L. 142. The outer containment cavity shall be equipped with an emergency leak-detection float switch for the leak detection and alarm system, which shall be provided as part of the scope of this work. The tank shall meet all the requirements of the City Fire Department for storage of hazardous materials and shall as a minimum include the following:
      (b) Primary tank venting shall be provided and shall be a minimum of 1.25" nominal inside diameter. The primary vent shall be extended to outside the building as shown on the mechanical plans. The normal vent shall have a screened mushroom style cap.
      (c) Emergency relief venting shall be provided for both the primary and secondary tanks. Rain protected, open style rupture basins are not acceptable. These vents shall be extended to outside the building as shown on the mechanical plans. The extended emergency vents shall be capped with U.L. listed pressure relief type caps designed to open at 2.5 PSI. Materials used for vent pipes, supply and return piping, valves and fittings shall conform to Article 79, Division VII.
      (d) A 5 gallon capacity overfill basin shall be provided around the fill pipe and shall include a means of draining spills back into the main

tank. The fill pipe shall be extended down into the fuel tank and terminate within 6" of the bottom of the tank.

(e) The high fuel sensor shall be wired to an audible and visual local alarm that shall be activated at 90% of the tank capacity. The alarm panel shall be mounted at the fill location and shall include a reset/silence for the alarm and a light that will automatically reset the controller for the next fill. An "off switch" is not acceptable.

(f) The tank shall include labels to indicate "Diesel Fuel". The lettering shall be 3" high, half inch stroke, red letters on a white background outlined in red.

(g) All of the above items shall be submitted for approval. Do not release the fuel tank for manufacture until it has been approved by the City Building and Fire Department.

3) Engine Fuel Pump: The engine fuel pump shall be a positive-displacement, engine-driven pump capable of supplying an adequate quantity of fuel to the engine under all operational conditions. Solenoid shut-off valve in fuel line discharge side of pump shall be interlocked with the emergency engine shutdown circuitry.

12. Output Circuit Breakers:
    a. Provide engine / generator mounted circuit breaker, rating as noted on the drawings.
13. Weather Protective / Sound Attenuated Enclosure:
    a. The generator set and accessories shall be completely housed in a weather protective and sound attenuated enclosure. The enclosures shall be a modular type with the generator sets mounted inside to meet the appropriate seismic Zone regulations and shall be able to withstand winds of up to 115 miles per hour.
    b. Material used for each enclosure shall be ASTM, A-569 steel, 12 gauge. A hinged access door shall be provided. The door shall be a double return type and shall be sealed with a neoprene gasket of the air seal type. A 3 point lockable, stainless steel with bronze thrust washer door handle shall be provided. Six (6) inch 40 oz. fiberglass sound insulation shall be provided on the interior walls and finished with pre-painted waffled aluminum sheeting which shall be held in place by weld fasteners.
    c. All areas inside the engine generator compartment, from floor level to six feet, shall have a 2 inch level suspended barium divider. Air intake and exhaust discharge shall be equipped with sound baffles as shown on the drawing. The sound level shall be 68 dba at 23 feet (or less) and zero to ten feet above the ground.
    d. The enclosure shall be preassembled at the factory. Final interconnections of all components shall be by the Manufacturer on site, except for the fuel and electrical connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The engine-generator set shall be mounted on a rigid steel chassis. This contractor shall be responsible for installation of the entire assembly within the space allocated, including vertical clearance and all required code clearances.

B. The Contractor shall submit a permit application to the local Air Quality Management District, which will require a site-specific screening application. If the air quality board concludes that a particulate filtering system will be required for this site, the Manufacturer shall provide to the Owner a proposal for any and all modifications to the engine-generator unit that will be required to meet the air quality requirements. Proposal shall include delivery and costs for all modifications.

C. Load tests shall be run as required in Paragraph 1.4 of this Section to the generator rated load after generator installation is complete. The Manufacturer for full-load testing of the generator shall provide auxiliary load banks. Manufacturer shall schedule the tests with the Owner so that final tests may be witnessed. Verify correct reading and operation of all meters, indicators and controls.

D. Readings required during both preliminary and final tests requested in Paragraph 1.4 shall be taken and shall include the following:
   1. Frequency.
   2. Voltage.
   3. Current.
   4. Wattage.
   5. Ambient temperature.
   6. Water temperature.
   7. Oil pressure and temperature.
   8. Protection: Provide protection facilities and procedures to prevent damage and deterioration.
   9. Verify utility phase rotation prior to connection of the Generator to the Building Distribution System. Modify the Generator output phase rotation to match the Utility Company.

3.02 INSTRUCTION AND MAINTENANCE

A. Instruct the Owner's personnel in the proper use, operation and maintenance of the set. Review emergency provisions, including emergency access and procedures to be followed at time of failure in operation and other building emergencies. Train Owner's personnel in the procedures to be followed, checking for the source of an operational failure or malfunction.
   1. Maintenance Period: Starting at the date of acceptance of Work, provide complete systematic inspection and maintenance for the first three months. Furnish trained experts and equipment to check, adjust, lubricate and otherwise maintain the generator set in operation without defects or deterioration. Replace or repair materials and parts, which become defective or deteriorated for any reason.
   2. Furnish a factory-trained Engineer for a minimum of one working day prior to final acceptance of the generator installation, or as needed to satisfy Owner that the system is functioning properly.
   3. Provide standard Manufacturer recommended selection of optional maintenance Contracts, for Owner selection of ongoing maintenance program for the new engine-generator installation.

END OF SECTION

SECTION 26 36 01

AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Provide an automatic transfer switch as shown on the drawings and as specified herein.

1.02 SUBMITTALS

A. Refer to Section 26 05 00 and 01 33 00 for procedure.

B. Shop Drawings and Product Data, including complete wiring diagrams, including system interconnections.

C. Test and Test Report for Automatic Transfer Switch:
   1. Visual and Mechanical Inspection:
      a. Inspect for physical damage.
      b. Compare equipment nameplate information and connections with single line diagram and report any discrepancies.
      c. Check switch to ensure positive interlock between normal and alternate sources.
      d. Check tightness of all cable connections and bus joints.
      e. Perform manual transfer operations.
      f. Electrical Tests for Automatic Transfer Switch:
         1) Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
         2) Set and calibrate in accordance with the Manufacturer's recommendations.
            (a) Voltage-sensing relays.
            (b) Transfer time delay relays.
            (c) Engine shutdown relays.
         3) Perform automatic transfer by:
            (a) Simulating loss of normal power.
            (b) Return to normal power.
         4) Monitor and verify correct operation and timing:
            (a) Normal voltage-sensing relays.
            (b) Engine start sequence.
            (c) Time delay upon transfer.
            (d) Alternate voltage-sensing relays.
            (e) Automatic transfer operation.
            (f) Interlocks and limit switch function.
            (g) Timing delay and retransfer upon normal power restoration.
            (h) Engine shutdown feature.
            (i) Correct functioning of auto-exercising controller.

D. Maintenance and operating instruction manuals. Submit four bound copies including approved Shop Drawings, parts list, list of recommended spare parts, sources of purchase and similar information.

1.03 REFERENCE STANDARDS

A. The following Specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this Specification to extend the indicated by the references thereto. Except where specific date is given, issue in effect (including amendments, addenda, revisions, supplements, and errata) on the bid date shall be applicable. In text such Specifications and standards are referred to by basic designation only.

B. National Fire Protection Association (NFPA)
   1. No. 70National Electrical Code (NEC)

C. Underwriters' Laboratories, Inc. (UL):
   1. No. 1008Automatic Transfer Switches
   2. No. 489Molded Case Circuit Breakers

D. National Electrical Manufacturers Association (NEMA):
   1. ICS 2.447Industrial Control and Systems

E. American National Standards Institute (ANSI):
   1. V37-90aGuide for Surge Withstand Capability (SWC) Tests

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. ASCO

B. Russelectric

C. Zenith

D. Onan

E. Kohler

F. Generac

2.02 AUTOMATIC TRANSFER SWITCH, GENERAL

A. The automatic transfer switch (ATS) shall be 3-pole and as rated as noted on the Drawings. Transfer switch shall be listed and labeled under UL-1008 as a device for use on emergency generator systems. ATS shall be mounted in a Nema 1 enclosure. ATS shall be the standard product of a company engaged in manufacturing automatic transfer switches for at least 10 years. ATS shall be manufactured so that no rear or side access is required.

2.03 CONSTRUCTION AND PERFORMANCE

A. Transfer Switch shall consist of completely enclosed 3 pole contact assembly and a separate control logic panel. The contact assemblies shall be operated by a stored energy mechanism, and be energized only momentarily during transfer providing inherently double throw switching action. Control power for all transfer operations shall be derived from the line side of the source to which the load is being transferred.

B. The transfer switch shall be a delayed transition type.

C. Transfer Switch shall be positively interlocked mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. A neutral position shall not be possible under normal electrical operation except that the switch shall be provided with a Delayed Transition accessory for switching highly inductive loads. Transfer Switch shall have a manual neutral position for load circuit maintenance. A Transfer Switch position indicator shall be visible from the front of the switch to show to which source the transfer switch is connected.

D. Transfer switch shall be capable of being operated manually under full load conditions. Manual operation shall be accomplished via integrally mounted pushbutton operators located on the face of the contact assemblies. Removable manual operation handles and handles which will move in the event the electrical operator becomes energized while performing a manual transfer operation are not acceptable. The manual operator shall provide the same contact-to-contact transfer time as provided under normal automatic operation to prevent possible flashovers from switching the main contacts slowly. In addition, provisions shall be provided to allow disengagement of the electrical operator during manual operation.

E. Transfer Switch shall have four extra sets of normally open and normally closed auxiliary contacts, which indicate ATS positions.

F. Transfer Switch shall be mounted in a Nema 1 enclosure.

G. A solid state sensing and control logic panel shall be separately mounted from the power-switching portion of the Transfer Switch. The two Sections shall be connected together by control cables with plug-in connectors. The control Section shall be capable of being disconnected from the power Section for maintenance purposes.

H. The logic circuit shall utilize differential sensing solid-state components mounted on printed circuit boards to accomplish proper operation and to perform functions such as timing and voltage and frequency monitoring. LED's on each PC card shall indicate the proper operation of each function furnished. Construction shall be such that functions cards are individually replaceable without requiring replacement of the complete solid-state package. Cards for plug-in modifications shall be available for field installation with retention of the UL label.

2.04 SEQUENCE OF OPERATION

A. Upon reduction of phase-to-phase voltage of the normal source to 80% of nominal, and after a time delay of 1-90 seconds (adjustable to meet field conditions) to override momentary dips and/or outages, the auxiliary engine start contacts shall close to initiate starting of the Emergency Generator.

B. After the Generator has reached 90% of nominal voltage and frequency, and after a time delay, ATS shall transfer the load to the Generator. Provide an under-voltage / under-frequency monitor for the Emergency/Standby Source.

C. When the Normal Source has been restored to 90% of rated voltage, and after a time delay adjustable from 0.5-30 minutes (to insure the integrity of the Normal Power Source), the load shall be retransferred to the Normal Source.

D. A time delay module shall be provided in the ATS, adjustable 0.5-30 minutes, to delay shutdown of the Emergency/Standby Power Source after retransfers to allow the generator to run unloaded for cool-down.

E. If the Emergency Generator should fail while carrying the load, transfer to the Normal Power supply shall be made instantaneously upon restoration of the Normal Source to satisfactory conditions.

F. ATS shall be provided with a Delayed Transition timer, adjustable 0-120 seconds. The ATS shall pause during transfer with both sources disconnected from the load, to allow back-EMF from large inductive loads to decay. Methods, which use relative phase-angle differences to control transfer, are not acceptable.

G. ATS shall be provided with 4 sets of Auxiliary Contacts to indicate 'Normal' or 'Emergency' Position of the ATS.

2.05 ADDITIONAL ACCESSORIES/SPARE PARTS

A. Provide an engine exercise timer in the ATS which shall automatically start the engine periodically. Timer shall be digital, with lithium battery back up. Provide a selector switch to select exercise with load transfer or without load transfer. The timer shall include a failsafe circuit, such that if the engine fails during exercise the ATS will immediately retransfer to the Normal source.

B. Provide pilot lights to indicate to which source the load is connected, and to indicate the availability of each power source.

C. The transfer switch shall be rated for the short circuit currents noted on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Section 26 05 00 for details of Work under this Section, including seismic installation requirements.

B. Testing: See Section 26 32 14.

END OF SECTION

SECTION 26 51 01

LIGHTING

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Luminaires (i.e., lighting fixtures). Refer to the Luminaire Schedule, and provide a complete and working Building Lighting System. Catalog numbers in the Luminaire Schedule are basic luminaire types. Additional features, accessories and options herein specified, described, or scheduled are to be included for all luminaires provided. ***NOTE****: A number of Existing Luminaires currently installed in the Historic 1941 wing of the Building, are to be removed, refurbished/re-wired/re-finished, and modernized with new LED light sources and dimming solid state power supplies, under a separate Contract by the Town of Colma, with C.W. COLE Lighting, of South Elmonte, CA, as indicated on the Plans.* The Contractor's Scope for these luminaires shall include: 1) take delivery of Owner-Supplied luminaires (including several (New) decorative and other luminaires, also included in the COLE Lighting Contract with the Town of Colma); 2) properly store and protect all Owner-Supplied luminaires, and: 3) install and connect complete all Owner-Supplied (existing) refurbished Historic and related traditional COLE Lighting luminaires provided by the Town of Colma, under separate Contract. ***All STANDARD (cataloged) C.W. COLE luminaires listed in the Luminaire Schedule, and NOT SPECIFICALLY IDENTIFIED AS "Owner Provided", shall be provided, installed and connected complete by the Sub-Contractor***. See: Luminaire Schedule, Lighting Plans and General Notes.

B. Lamps. Provide all lamps for all luminaires of size and type as recommended by the luminaire manufacturer and as scheduled, or specified herein.

C. Provide lamps for all existing luminaires to remain (to be re-lamped).

D. Ballasts and power supplies/drivers, including standard and dimmed fluorescent, standard and dimmed, integral and remote-mounted, Solid State LED.

E. Lighting controls, including motion sensors, automatic daylight dimming, and re-programming/reconnection and re-use of Existing Lutron 'Grafik Eye' programmable Dimming Systems at Council Chambers. See Section 26 57 00 for Low Voltage Lighting Control System.

F. Exit and Emergency Egress lighting where indicated and where required.

G. Supports for outlet boxes and luminaires, including seismic restraint slack wires for recessed luminaires in suspended ceilings per code and backing in walls as required to keep luminaires secure and level.

1.02 INCORPORATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this section.

B. Section 26 05 00 and 26 27 00 apply to all work in this section.

C. Division 03: Concrete (Bases for pole-mounted luminaires as noted in Luminaire Schedule).

D. Division 09: Painting and Finishes (cutting of holes in finished surfaces for recessed luminaires).

1.03 RELATED WORK

A. Ceiling Access panels where required for access to equipment, outlets, transformers, etc., located above suspended ceilings, sheet rock or plaster ceilings. Coordinate with the Architect and other trades.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00 and 26 05 00.

B. The Contractor shall furnish (6) six sets of submittals for review by the project team unless otherwise noted in these specifications. The submittals shall include the following information:
   1. Product Index: The following information shall be included in the product index.
      a. Luminaire Type. The index shall call out each luminaire type per the Luminaire Schedule in the Contract Documents.
      b. Manufacturer’s Catalog Number. Outstanding information required to make a complete catalog number shall be clearly identified in the index.
      c. Where a pole is included with the luminaire, include the catalog number of the pole in addition to that of the luminaire.
      d. Lamp Data. Provide the Manufacturer’s name and Catalog Number for each lamp including wattage, color temperature, and color rendering index.
      e. Comments. The index shall include a column for comments. The comments column shall include extraneous information required for clarity.
   2. Manufacturer's literature for every luminaire listed on the Luminaire Schedule.
      a. Catalog Information:
         1) Luminaire Data Sheet: The manufacturer’s cut sheet shall include the following:
            (a) Photometrics: Candlepower distribution curve or table with horizontal readings at 0, 22.5, 45, and 90 degrees and vertical readings from 0 to 180 degrees in 5 degree increments in accordance with the Illuminating Engineering Society published test procedures.
            (b) Catalog Number Nomenclature
            (c) Coefficient of Utilization Tables
            (d) Luminaire Line Drawing
            (e) Ballast (each type)
   3. Data sheets for electronic ballasts and drivers. Indicate luminaire types on applicable ballast/driver data sheets.
   4. Data sheets for wallbox controls and other products specified in this section.
   5. Shop Drawings:
      a. Provide shop drawings and mounting/suspension details for luminaires recessed in, mounted on, or suspended from hung or framed ceilings, or from

open structural roof and/or floor decks, or recessed in, or mounted on framed walls. Details shall clearly illustrate proposed methods for supporting luminaires independent of suspended ceiling system(s), where applicable; indicate any and all required structural 'blocking' required for proper luminaire installation, to be provided by Contractor.

b. Detailed shop drawings of all linear cove/wall, or box mounted LED or fluorescent luminaires shall contain the following information:
   1) Exact field measured length (clear inside dimension) of cove pocket or box.
   2) Exact luminaire length and arrangement of luminaires in cove or box.
   3) Detailed, dimensioned/to-scale shop drawings of pendant and/or cable suspended, surface ceiling and/or wall mounted, and cantelever-arm wall mounted luminaires constructed with linear metal housings containing the following information:
      (a) Support mechanisms, including pendant stems, swivel canopies and sway adapters at points of connection to luminaire housings, aircraft suspension cables, ceiling anchors, including decorative canopies, adjustable cable stops and hydraulically-crimped connectors, and all associated miscellaneous hardware, etc.
      (b) Lengths of all suspension stems and/or cables lengths and locations on linear housings (dimensioned).
      (c) Trim details.
      (d) Closure piece details.
      (e) 90 degree corner and 'Tee' connector assemblies.
      (f) For each section of linear luminaire housing(s), indicate and dimension exact location(s) of all: a) suspension cables and/or pendant stems; b) 'Normal' and 'Emergency' Power feed pendant stems and/or power cord drops; c) separately connected 'Emergency' luminaire modules; d) manufacturer-provided and installed photosensors.
      (g) Rectilinear Pattern configurations, complete with all Corner and Tee connectors indicated, drawn to scale and dimensioned.
      (h) Lamp row(s) switching and/or dimming control zoning, including Tandem switching and/or dimming arrangements and/or separately controlled luminaire sections/modules in the same linear 'run' (to verify compliance with each specific control arrangement indicated on the Lighting Plans).
   4) Provide shop drawings with remote driver locations which identifying the drivers manufacturer; quantity and connection locations with the exact routing of the conduit which shall be determined by the manufacturer.
      (a) LA-Series.
      (b) LAD-Series
      (c) LAE-Series.
      (d) LM-Series.
      (e) LK-Series.
      (f) LT-Series
      (g) LAP1-Series
      (h) LAW-Series

6. Samples:
   a. Provide samples of luminaire trim where "Finish as selected by Architect" is indicated on the luminaire Schedule. Submit two finish samples, 75 mm x 75

mm (3" x 3") minimum, of all custom color, decorative metal, or anodized aluminum finishes. Samples must be approved in writing by the Architect prior to ordering.

7. Schedule of spare lamps.
   a. Provide a schedule indicating the type and quantity of spare lamps to be provided to the Client at project closeout.
   b. Refer to article 3.06 below for specific lamp information.
   c. Refer to Section 01 60 00 - Product Requirements.

C. For Any Luminaires Substituted For Those Specified:
   1. Refer to section 01 60 00 - Product Requirements, for all substitution procedures.
   2. Provide independent testing laboratories, Inc., or equal, photometric test report for each Luminaire type and lamp combination listed on the Luminaire Schedule. Test reports shall be based on Illuminating Engineering Society published test procedures and shall contain polar coordinate candlepower distribution curves in five lateral planes for luminaires with asymmetric distributions and luminaire luminance data for vertical angles above 45 degrees from nadir. Test results shall indicate luminaire efficiency for the lamp and aperture assembly specified. luminaires with efficiencies more than 2% below the values of specified luminaires are not acceptable and will be rejected.
   3. Prior approval does not guarantee final approval by the electrical engineer. The contractor shall be completely responsible for providing luminaires that meet or exceed the quality/performance of the specified products in their entirety. All deviations in quality/performance of the specified products must be listed and individually signed off by the engineer.
   4. The Owner reserves the right to reject a proposed substitution based on his agent’s professional judgment as to the utility, visual appropriateness, or finish of substitutions.

1.05 OCCUPANCY SENSORS

A. Equipment Qualification
   1. Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.
   2. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.
   3. Contractor/Supplier shall examine all general specification provisions and drawings for related electrical work required as work under Division 26.
   4. Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, luminaires, HVAC systems and building management systems.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site and store in unopened cartons in protected location. Inspect products immediately and report all damage accordingly.

1.07 GUARANTEE AND WARRANTIES

A. All work performed under this section must be guaranteed to be free of defects in products or workmanship for one year after date of acceptance by Owner, unless noted otherwise in General Conditions.

B. Warranties:
   1. Electronic ballasts and LED power supplies must be warranted against failure for five years after date of substantial completion.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide luminaires as indicated in the Luminaire Schedule (except those identified as 'Owner-Provided'; if conflict exists between Luminaire Schedule and Specifications, the more stringent requirement shall take precedence.

B. Provide luminaires new and complete with mounting accessories, junction boxes, trims, and lamps.

C. Provide products with UL labels appropriate to intended installation conditions, or with labels from other testing laboratories whose results are acceptable to local inspector, showing compliance with UL standards. Labels must be concealed from normal viewing angles.

D. All products of same type by same manufacturer.

2.02 LUMINAIRE CONSTRUCTION

A. Sheet metal: materials and thicknesses shall be 20 gauge (0.7 mm or 0.027") min., free of dents, scratches, oil-can, or other defects.

B. Painted luminaires: exposed weld marks, joints, and seams shall be filled and sanded smooth before finishing.

C. All edges cleaned and dressed to remove sharp edges or burrs.

D. Extrusions: 1/10" min. wall thickness, smooth and free of tooling lines, with cast end plates that exactly match extrusion profiles.

E. Castings: smooth, free of pits, scales, gate marks, or blemishes.

F. Spinnings shall have 1/32" min. thickness, smooth, free of spinning lines or blow-back, with clean edges.

G. Welds: Follow recommendations of American Welding Society. All welds continuous and free of spatter, residue, or warping.

H. No light leaks visible in finished room. Ensure that downlight housings mounted in wood slat ceilings are not visible from below. Field paint exterior of housing with high temperature paint if necessary.

I. Exposed end plates and joiners, with concealed fasteners.

J. End-to-end mounted luminaires: Verify row configurations and provide joiners, aligning splines, and trims to suit.

K. Hardware:
   1. Steel or aluminum interior luminaires: cadmium-plated hardware.
   2. Steel or aluminum exterior luminaires: stainless steel hardware.
   3. Stainless steel luminaires: stainless steel hardware.

L. Raceways: Where used for through wiring, luminaires must be approved for use as raceways.

2.03 RECESSED LUMINAIRES

A. Point-source luminaires: provide pre-wired junction box and thermal protection, and provide slack wires to structure at two diagonal corners.

B. Troffer luminaires: provide hold-down clip at each luminaire corner, and slack wires to structure as detailed on the drawings. The detail will take precedence.

C. Verify ceiling construction details and provide luminaire housings and trims to suit.

D. Non-accessible ceilings: Provide access to junction boxes, ballasts, transformers, and battery packs through luminaire apertures; no access panels in ceiling.

E. Mounting frames: To prevent rusting, provide galvanized steel or cast aluminum frames for installation in damp locations or in plaster ceilings.

F. Adjustable luminaires shall be provided with rotation and tilt locking devices.

2.04 PENDANTS

A. Stem-mounted: 16 mm (5/8") max. o.d. stem with ball swivels at top (and bottom of linear luminaires) to permit 45 deg. swing in any direction away from vertical. Flat canopy to permit splice inspection after installation. Pendants must permit +/- 13 mm (½") threaded vertical adjustment after installation, leaving at least 6 mm (1/4") thread contact at all points.

B. Provide internal safety cable from luminaire body to stud in outlet box.

C. Cable-mounted: 1 X 7 strand 3/32" diameter stainless steel aircraft cable, factory crimped, independently tested and verified to exceed 1500 pounds.
   1. Verify mounting heights for each luminaire and provide cable lengths and coordinate cord lengths with manufacturer as required prior to ordering luminaires. Provide aircraft cable adjuster nipple with locking jaws.

D. Supports: Carry luminaire weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.

2.05 TRIMS

A. Trims must fit tightly and be held in by gravity, spring clips, or mechanical fasteners. Trims must not drop out under normal conditions or seismic forces which do not exceed the design criteria of the building.

B. Aluminum parabolic cones shall be smooth, properly shaped, with Alzak finish in colors as indicated.
   1. No hot spots or lamp images visible at angles shallower than lamp shielding angle.
   2. Self-flange cones must bend parallel to ceiling and cover ceiling hole without additional trim ring. Unpainted flange, shall have the same finish as cone interior.
   3. Cones and louvers for fluorescent luminaires must have permanent anti-iridescence treatment.

C. Lenses, diffusers, and patterned glass: glass or virgin acrylic as noted, with patterns as noted.
   1. Finished thickness 2 mm (1/10") min. unless noted otherwise.
   2. Linear runs over 1200 mm (4'-0") long shall be in equal-length pieces.
   3. Lenses for tungsten halogen luminaires shall be tempered borosilicate glass.
   4. Lamp enclosures for metal halide lamps shall be glass or acrylic and must be capable of retaining lamp fragments in the event of non-passive lamp failure.
   5. Glass UV filters for individual accent luminaires, where indicated, shall be 3 mm (1/8") borosilicate glass filters with dichroic coating, 2% max. light transmission @ 400nm, 80% min. transmission @ >425nm, Bausch & Lomb "Optivex" or equal by Balzers.
   6. Acceptable Manufacturers:
      a. Plastic lenses and diffusers: ALP, ICI/KSH & Haas.
      b. Glass lenses and patterned glass: Balzers, Bausch & Lomb, Gray.

2.06 FINISHES

A. Steel Reflectors: Unless otherwise specified, the reflector surface finish shall be of synthetic white enamel or polyester powder coating. Finish shall show no indication of chipping, cracking, flaking or any other sign of loss of adhesion. The initial reflection factor shall be not less than 88 percent averaging 5 randomly selected points on the reflector. After 100 hours of exposure to the radiation of a glass enclosed carbon arc lamp, such as a Fade-O-Meters, the reflectance of the exposed portion shall not be less than 5 percent and finish shall show no appreciable color change. The carbon arc lamp shall be operated at appreciable color change. The carbon arc lamp shall be operated at 13 plus or minus 0.5 amperes at 140 volts. The reflector shall be placed ten inches from the arc and the lamp so ventilated that the temperature of the exposed portion does not exceed 105 degrees F.

B. Aluminum Reflectors: Reflecting surfaces shall be provided with either a specular or diffuse finish as indicated. Reflection factors shall be not less than 83 percent for specular reflecting surfaces. Each reflecting surface shall be protected by dense coating of oxide weighing not less than 5.0 milligrams per square inch, applied by an anodic process. The reflector shall be given a sealing treatment that will prevent

staining of the reflecting surface when subjected to a stain test. All aluminum reflectors & louvers shall be a low iridescent equivalent to that provided by Coil Anodizers.

C. Non-Reflecting Surfaces: Unless otherwise specified, the finish on all non-reflecting exterior surfaces shall be aluminum oxide or aluminum; white, gray or aluminum paint on steel; nickel or chromium plating on copper alloy. Fastening devices shall be nickel, chromium, cadmium or zinc plated. All painted surfaces shall be free of tears, star marks, blisters, pinholes, chipping and any other defects that may impair appearance or serviceability.

2.07 LAMPS

A. Unless otherwise noted, lamps described in the Luminaire Schedule and in these Specifications shall be manufactured by General Electric, Osram/Sylvania, North American Philips, Venture, or approved equal.

B. Each type of lamp by only one manufacturer to maintain color consistency.

C. Relamp luminaires at no cost to the District if lamps exhibit excessive lamp to lamp color variation or burn out within 90 days of substantial completion date.

D. Fluorescent:
   1. Fluorescent lamps shall be 265ma full wattage, T8; 3500 deg. K color temperature; min. CRI 82; 2ft., 3ft. & 4ft. lamps. Provide TCLP compliant reduced mercury content lamps whenever such lamps are available.

E. LED:
   1. L.E.D. Diodes: High efficacy Light Emitting Diodes (L.E.D.s) shall provide min. 70 lumens/watt in combination with specified solid state electronic static and dimming drivers; acceptable manufacturers: Philips ‘Lumileds’ or CREE, as noted.
   2. 3500 deg. K color temperature, unless otherwise noted.F.

2.08 BALLASTS, DRIVERS AND TRANSFORMERS

A. General:
   1. Verify input voltages and match to branch circuit voltages.
   2. Provide ballasts with best-made sound ratings for each type and mount securely to prevent vibration.
      a. Replace excessively noisy ballasts or transformers at no cost to Owner.
   3. Remote ballasts or transformers: Provide suitable enclosures and mounting hardware, and install in accessible, ventilated locations.
      a. Secondary wiring: provide number and size of conductors as required, with 3% max. voltage drop between transformer and last lamp.
      b. Keep ballasts or transformers at least 300 mm (12”) apart and do not stack vertically.
   4. Ballasts must contain no PCB’s and be labeled accordingly.

B. Fluorescent Ballasts:
   1. Ballasts must meet applicable energy-conservation standards.
   2. Interwiring (for electronic ballasts):
      a. In linear luminaires or continuous rows of individual luminaires, provide tandem wiring to operate each row of lamps independently. Provide

three-lamp and four-lamp ballasts where possible, two-lamp ballasts only where needed to finish a row.

b. In individual one-lamp luminaire, provide two-lamp ballasts and master-slave interwiring between pairs of luminaires where possible.
c. In individual two-lamp luminaires, provide two-lamp ballasts and interwiring between pairs of luminaires to operate one lamp in each luminaire on each ballast.
d. In individual three-lamp or four-lamp luminaires, provide two-lamp ballasts and interwiring between pairs of luminaires to operate all outer lamps independently of all inner lamps.
e. In master/slave three-lamp or four-lamp luminaires, provide one two-lamp ballast and one four-lamp ballast and master-slave interwiring between pairs of luminaires with and interwiring between pairs of luminaires to operate all outer lamps independently of all inner lamps.

3. Electronic ballasts for long fluorescent lamps 97% min. power factor, “A” sound-rated, with UL Class P thermal protection, 85% min. ballast factor with specified types and numbers of lamps. Ballasts must operate specified lamps within lamp manufacturer’s specifications and have no effect on rated lamp life when run on a three-hour switching cycle (3 hours on and 20 minutes on off).
   a. Programmed Start operation, with starting voltage and filament current in compliance with applicable ANSI standards for each lamp type. Resistance of the heated lamp filaments (Rh) shall be at least 4.0 times greater than the resistance of the cold lamp filaments (Rc).
   b. Ballasts with Instant Start operation may be used in fluorescent systems where less than 5 lamp starts per day are anticipated and where occupancy sensors and/or T5 and T5HO lamps are not used.
   c. Parallel-wired.
   d. Provide interwiring and number of lamps per ballast as described under “Interwiring” above. Follow manufacturer’s recommendations for maximum whip length.
   e. Light variation 10% max. with +/- 10% input voltage variation.
   f. Electromagnetic radiation must not exceed FCC Part 18 regulations.
   g. Surge and transient protection per IEEE 587, Category A and ANSI C62.1-1984.
   h. End of life protection to guard against lamp delamination.
   i. Harmonic distortion: Total harmonic distortion (ratio of total harmonic RMS current to fundamental RMS current) must be less than 15% or as required to meet local utility requirements, whichever is lower.
   j. Fluorescent Dimming Ballasts shall be Lutron Hi-Lume electronic type, providing 100% - 1% dimming range.
   k. Acceptable Manufacturers:
      1) Electronic: EBT, Universal Lighting Technologies, Osram/Sylvania, Advance, General Electric.
      2) Electronic Dimming: Lutron, no substitutions.
      3) Short compact fluorescent: Advance, Robertson, and Universal.

2.09 BALLASTS AND L.E.D. POWER SUPPLIES: BALLASTS AND L.E.D. POWER SUPPLIES/DRIVERS SHALL MEET APPLICABLE ENERGY-CONSERVATION STANDARDS.

A. Fluorescent Ballast and/or L.E.D. Power Supply/Driver manufacturer(s) shall recommend number of drivers, connection locations and exact terminating point of power supply and control cabling conduit(s) for all luminaires, where they are not installed integral to the luminaire housing.

B. Remote ballasts, transformers and L.E.D. power supplies/drivers: provide suitable ventilated enclosures and mounting hardware, complete with proper descriptive engraved and laminated Labels (cover mounted for Enclosures, individual lables mounted beneath each ballast and/or power supply within Enclosures), and install in accessible, ventilated locations. NOTE: Verify exact mounting locations of all remote power supplies/drivers for suspended and/or wall-mounted linear L.E.D. luminaire assemblies, with the Architect, prior to rough-in, at any and all areas where proposed locations of remote Enclosures will be exposed to view.
   1. Secondary wiring: provide number and size of conductors as required, with 3% maximum voltage drop between transformer and last lamp.
   2. Keep ballasts, transformers and/or L.E.D. drivers at least 300 mm (12”) apart and do not stack vertically.
      a. Dimmable LED Power Supplies/Drivers:
         1) Dimming Range: Continuous dimming from 100 percent to one percent relative light output unless dimming capability to lower level is indicated, without flicker.
         2) Control Compatibility: Fully compatible with the dimming controls to be installed.
            (a) Wall Dimmers
            (b) Network Lighting Controls: See Section 26 57 00.

2.10 EMERGENCY LIGHTING AND EXIT SIGNS

A. Emergency lighting: Provide lighting for paths of egress as required by code.

B. Exit signs shall be edge-lit LED, surface-mounted on ceiling or wall.
   1. Fabricated or diecast aluminum construction, no light leaks around canopy. Plain box, with no decorative trim.
   2. Letters shall be 20mm (3/4”) stroke, 150 mm (6”) high, brightness and evenness of illumination per code, green color.
      a. Green LED lamps located at interior perimeter for indirect illumination of stencil letters.
      b. Provide finish as specified in the Luminaire Schedule.
      c. Apply the arrows as indicated on the plans.

C. Emergency luminaires supplied by a separate emergency power source.
   1. For luminaires supplied by a separate emergency power source, provide "switched" control of the emergency designated lamps to allow complete "off" control when required by the user. The switched control shall include an automatic transfer feature to automatically turn "on" the emergency designated lamps upon the normal source power failure.

2. Automatic transfer function shall be provided using a UL 924 listed relay, LVS Inc. #EPC-A or equal, suitable for mounting in a standard 4" square j-box (min. 2.5" deep). Transfer relay shall provide automatic diagnostic test feature which shall maintain power to the emergency designated lamps for 15 seconds after the room is switched off via the respective light switch or control relay. Emergency designated lamps shall turn off after the 15 second test period and shall come back on when the control device is turned back on to restore full lighting to the space.
3. Provide (1) transfer module per "switched" zone.

D. Emergency luminaires supplied by a dimmer panel and/or emergency source.
1. For luminaires supplied by a dimmed power source, provide "dimmed" control of the emergency designated lamps to allow normal dimming control with the normal lamps. The dimmed control shall include an automatic transfer feature to automatically turn "on" the dimmed lamps to full light output upon the normal source power failure.
2. Automatic transfer function shall be provided using a UL 924 listed relay, LVS Inc. #EPC-D (2-wire dimmed), #EPC-D-U (3-wired dimmed) or equal, suitable for mounting in a standard 4" square j-box (min. 2.5" deep).
3. Provide (1) transfer module per "dimmed" zone.

2.11 WALL-BOX DIMMERS

A. Dimmers: Lutron Nova-T series, of size and type appropriate to loads, finish to match switches. Provide separate neutral conductor from panel to loads on each phase to prevent cross talk between phases.
1. Fluorescent: Provide dimmers and compatible Lutron Hi-Lume electronic dimming ballasts. Provide one neutral and two hot conductors between dimmer and load.

B. Ganging and Labeling:
1. Dimmers and matching switches in same location shall be installed in same gang box.
2. Follow dimmer manufacturer's instructions for gang-box sizes. Do not break off fins on dimmers unless noted otherwise.
   a. 1+1, 4+1, 7+1 installation: to gang an even number of small devices without breaking off fins, provide multi-gang box as indicated (1, 4, or 7 gangs) and provide additional single-gang box at end, with ears of single box 70 mm (2-3/4") o.c. from last set of ears on multi-gang box.
   b. When rows of devices are stacked vertically space rows 230 mm (9") o.c. to allow heat dissipation.
3. Provide Lutron multi-gang plates to cover each group of devices.
4. Plates with "-NFB" in catalog number with no fins broken.
5. Plates with "-FB" in catalog number: break off all interior fins on devices, but do not break off outside fins at either end of row.
6. Nova-T: install aligning backplate (provided by Lutron with each multi-gang plate) between wall and devices.
7. Labels: text as indicated 3 mm (1/8") high, all capital letters, engraved on device faceplate, filled with black paint and wiped clean.

PART 3 - EXECUTION

3.01 PREPARATION

A. Architectural Reflected Ceiling Plans shall govern exact location and mounting conditions for all luminaires. Subcontractor shall be responsible for coordination of luminaire mounting and compatibility with ceiling construction and other trades.

B. Coordinate work with other trades. Location of lighting has priority over location of new framing (except major structural members), ducts, diffusers, sprinklers, speakers, smoke detectors, and other obstructions.

C. If obstructions are encountered which prevent installation of luminaires according to drawings, notify Architect immediately and do not proceed until conflict has been resolved.

D. Coordinate the location of luminaires in mechanical or unfinished spaces. Locations shown on Drawings may be adjusted by the Contractor to suit conditions. Install luminaires to avoid obstructions and maximize light output, 2100 mm (7'-0") min. mounting height.

E. Coordinate the location of any exposed conduit used to feed luminaires with the Architect prior to installation.

3.02 INSTALLATION

A. General:
   1. Subcontractor shall be responsible for handling and installation of luminaires - including Luminaires Provided by the Town of Colma, as described in Paragraph 1.1.A above - including all supports, hangers and hardware necessary for a complete installation. Luminaires shall be clean, plumb, level in straight lines, without distortion. Luminaires must be installed so they do not shift during relamping or adjustment. Remedy any light leaks which may develop after installation of recessed or enclosed luminaires.
   2. Install luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that luminaires fulfill requirements.
   3. Point-source luminaires shall be located as dimensioned, or in center of tile or on tile joint as drawn; 6 mm (1/4") max. off-center tolerance.
   4. Linear luminaires shall have 3 mm (1/8") max. horizontal or vertical alignment variation in any 5 m (16-ft.) portion of run.
   5. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds. 486 A and B, and the National Electrical Code.
   6. Clean luminaires of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.
   7. Remove and replace luminaires that may have been damaged during construction at no additional cost to the Owner.

8. Protect installed luminaires from damage during remainder of construction period.
9. Provide equipment grounding connections for luminaires as indicated. Tighten connections to comply with tightening torques specified in UL 486 A to assure permanent and effective grounds.
10. Install luminaires, lamps, lenses, etc., after building is enclosed, weather tight and environmental conditions are nominally the same as expected for the complete spaces. All lamps, glassware, reflectors and refractors shall be clean and free of chips, cracks and scratches.
11. Lamps installed for use as temporary lighting prior to approval shall be replaced with new lamps. Replace all burn outs with specified lamp prior to project closeout.
12. All wall mounted luminaires and all ceiling mounted surface luminaires including exit lights shall be fed through a luminaire Stud/Hickey/Nipple assembly and with provisions to prevent luminaire turning.
13. Installation of exit signs shall be coordinated with other trades to ensure signs are visible as intended.
14. All junction box cover plates for the lighting branch circuit system shall be clearly marked with a permanent ink felt pen identifying the branch circuit and control relay (panel number, circuit number, lighting control cabinet designation and control relay number) contained in the box.
15. Provide permanently affixed adhesive labels with machine printed lettering (min. 1/8" high) at junction boxes serving luminaires that are supplied by (2) electrical sources (i.e. normal and emergency lighting). Label to read "CAUTION - This light fixture is powered by two separate sources. The normal power source breaker and the emergency power source breaker must be turned off before servicing this light fixture."

B. Recessed Luminaires:
1. The contractor shall be responsible to verify the fire rating of the ceiling system within which the luminaires are to be mounted. Where luminaires are installed in fire rated ceilings (and as required by code), provide fire rated enclosures around and over luminaires to maintain ceiling fire rating. No additional cost shall be allowed for failure to include such enclosures and installation in the bid.
2. Holes for Recessed Point-Source Luminaires: Cut holes to follow luminaire housings exactly so no gaps will be visible after trims are installed.
3. Install bottom of housing aligned with finished ceiling.
4. Keep ceiling insulation at least 75 mm (3") away from luminaires.
5. Install trims after painting of spaces. Install trims tightly, with no gaps or light leaks.
6. Seismic restraints: Provide and install slack wires and hold-down clips per code.
7. Wallwashers:
   a. Orient wallwasher housings according to manufacturer’s instructions to maximize brightness on the upper portion of the wall.
8. Lamp Orientation:
   a. In situations where luminaires with horizontal lamps are aligned with each other, orient the lamps such that the axis of the lamps are in the same direction.

C. Ceiling-Mounted and Suspended Luminaires:
1. Provide support for outlet boxes and suspension points so luminaires can be installed securely, including seismic supports per code.

a. Luminaire weight less than 25 kg (50 lb.) at each suspension point: hang from strap or stud on outlet box, or at non-feed points, provide 1/4"-20 stud projecting 20 mm (3/4") below ceiling.
b. Luminaire weight 25 kg (50 lb.) or more at each suspension point: hang directly from structure, either independent of outlet box or from stud extending through outlet box to structure.

2. Stem-mounted:
   a. 16 mm (5/8") max. o.d. stem with ball swivels at top (and bottom of linear luminaires) to permit 45o swing in any direction away from vertical. Flat canopy to permit splice inspection after installation. Pendants must permit +/- 13 mm (½") threaded vertical adjustment after installation, leaving at least 6 mm (1/4") thread contact at all points.
   b. Provide internal safety cable from luminaire body to stud in outlet box.
   c. Provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting.
   d. Provide diagonal seismic restraint wires above ceiling per code.
   e. Furnish suspended luminaires with universal joint type hanger canopy (and longitudinal sway adapter at each stem connection point for linear luminaires), to permit 45 degree swivel on 360 degree circle from Nadir at canopy (and 45 degree longitudinal movement at sway adapter).
   f. Luminaires over 450 mm (18") wide shall be provided with supports at all corners.
   g. Install pendants plumb and level.
   h. Verify luminaire weights and provide backing in ceiling as required.
3. Cable-mounted: 1 X 7 strand 3/32" diameter stainless steel aircraft cable, factory crimped, independently tested and verified to exceed 1500 pounds.
   a. Verify mounting heights for each luminaire and provide cable lengths and coordinate cord lengths with manufacturer as required prior to ordering luminaires. Provide aircraft cable adjuster nipple with locking jaws.

D. Wall-Mounted Luminaires:
   1. Mounting heights shown on Drawings are measured from finished floor to centerline of outlet box or recessed housing, unless otherwise noted.
   2. Verify luminaire weights and provide backing in wall as required. Luminaires must not droop or tilt away from wall.
   3. Wet locations: install sealant between luminaire and outlet box.
   4. In circulation areas, wall-mounted luminaires must not project more than 100 mm (4") from wall if mounted above 685 mm (27") and below 2030 mm (80").

3.03 LIGHTING CONTROLS

A. Lighting controls to include occupancy sensors in most spaces (for local control) and relay system lighting control for larger common spaces.

B. Occupancy sensors shall initially be set as follows:
   1. Maximum sensitivity.
   2. Maximum time delay (or 30 minutes).
   3. Manual-on operation.
   4. Automatic off operation.
   5. Aim all adjustable sensors to properly cover room areas.

C. Timeclock System shall initially be set to control the low voltage relays as per the Relay Panel Schedules.
   1. Assign all interior relays to an automatic off sweep, with flick warn (except those noted as "NL"). Off time shall be set to an owner determined time in the evening, after dark or normal business operations.
   2. Off signals to originate from BAS system, which shall be inter-connected to the Lighting Control System.
   3. Assign all interior relays noted as "NL" to be on 24 hours per day. No automatic relay operation.
   4. Assign "after hours" and "Weekend / Holiday" hours to match normal business calander and times.
   5. All interior relays shall be allowed to be overriden by use of the local dataline switches for a maximum of 2 hours (per Title 24) when used after hours or on Weekends / Holidays. If used during these times, automatic shut-off shall re-activate at the end of the 2-hour period.
   6. All interior relays shall be allowed to be overriden by use of the local dataline switches when used during normal business hours. Standard timeclock operation shall resume with the next scheduled timeclock function for each relay.
   7. Assign all exterior relays for automatic on operation with the astro-dial feature, set to 30 minutes before sunset. Latitude = 37.5 degrees North / Longitude = 122 degrees West.
   8. Assign exterior relays noted as "astro-on, astro-off" for automatic off operation with the astro-dial feature, set to 30 minutesd after sunrise. Latitude and Longitude as noted above.
   9. Assign exterior relays noted as "astro-on, timeclock-off" for automatic off operation with the normal timeclock feature, set to an owner determined time in the late evening.
   10. Assign exterior relays noted as "NL" or "On All Night" for astro-dial operation, for automatic on 30 minutes before sunset and automatic off 30 minutes after sunrise.

3.04 DELIVERY, STORAGE, & HANDLING:

A. Deliver lighting luminaires in factory-fabricated containers or wrappings, which properly protect luminaires from damage. Inspect luminaires immediately upon delivery to ensure correct shipment without damage.

B. Store luminaires in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat and blocked off ground.

C. Handle luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new. Protection wrapping on louvered (parabolic) luminaires shall not be removed until luminaires are ready for operation.

3.05 SEQUENCING AND SCHEDULING:

A. General:

1. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of luminaires with other work.
2. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

3.06 PROJECT CLOSEOUT

A. Clean luminaires and remove plaster and paint spatters.

B. Clean fingerprints and dust from downlight reflectors. Refer to manufacturer's instructions.

C. Verify that luminaires and controls are working at time of final acceptance by Owner.
   1. Relamp as required.

D. Test emergency lighting system for 90 minutes in presence of Owner's representative, check each luminaire for proper operation at end of 90-minute test, then recharge for 24 hours and briefly test each luminaire again for proper operation.

E. Install and aim adjustable lighting as directed by Architect.
   1. Provide personnel, lifts, ladders, and walkie-talkies as required.
   2. Aiming will occur at night, outside of normal working hours, at times as approved by the Architect.

F. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hardcover binder. Deliver to Architect. After review, Architect will deliver one copy to Owner.
   1. One complete set of approved submittals, including product data and shop drawings.
   2. List of lamps used in Project, cross-referenced to luminaire types, with specific manufacturer's names and ordering codes.
   3. Relamping instructions for lamps that require special precautions (tungsten halogen, metal halide, etc.).
   4. Luminaire cleaning instructions, including chemicals to be used or avoided.
   5. Instructions for code-required testing and maintenance of emergency lighting system.
   6. Identification of lighting products that contain hazardous materials or that require special disposal techniques (large quantities of fluorescent lamps, etc.)

END OF SECTION

SECTION 26 56 01

SITE LIGHTING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Luminaires

B. Lamps

C. Ballasts and Drivers

D. Poles

E. Pole bases

F. Controls and wiring

1.02 SYSTEM DESCRIPTION

A. Furnish all labor, materials, apparatus, tools, equipment transportation, temporary construction and special or occasional services as indicated on the Drawings or described in these Specifications and as required to make a complete working Lighting System.

B. Illumination levels shall be in accordance with recommendations by the Illuminating Engineering Society (IES).

1.03 INCORPORATED DOCUMENTS

A. Section 26 05 00 applies to all work in this Section.

1.04 SUBMITTALS

A. Catalog Information:
   1. Luminaire (each type) with photometric pattern.
   2. Contactors.
   3. Ballast or Driver (each type)
   4. Poles.
   5. Brackets.

B. Shop Drawings.

C. Manufacturer's Recommendations: Provide two copies before material is used.
   1. PVC conduit joints and junctions.
   2. Solvent welding directions.
   3. Pole bases.

D. Laboratory Test: Determine soil density relationships for compaction of backfill material in accordance with ASTM D1557, Method D.

PART 2 - PRODUCTS

2.01 MATERIAL AND EQUIPMENT

A. Provide new materials and equipment unless otherwise specifically indicated or specified. Materials shall be listed by Underwriter's laboratories, Inc. (U.L.) and bear evidence of such approval where applicable.

B. Luminaires: Site luminaires shall be weatherproof LED with integral driver unless otherwise noted. Reflectors and refractors shall provide the light configuration indicated and conforming to IES recommendations.

C. Luminaires and poles shall be finished in epoxy enamel designed to withstand the effects of salt spray. Lens shall be securely attached to the lens frame for security during maintenance and relamping.

D. Lighting Contactors: NEMA ICS 2. Electrically operated, magnetically held unit in NEMA enclosure, rated poles and ratings as indicated on Drawings. Units shall have silver alloy double breaker contacts and coil clearing contacts and shall require no arcing contacts. On-off selector switch.

E. Poles, Brackets, Pole Bases and Attachments: Shall be rated for service with wind velocities of 100 mph considering the force exerted by the wind on the maximum exposure of the fixture luminaire selected.

F. Poles shall be anchor base type round, height and style as indicated, complete with handhole and gasketed cover, anchor bolts with leveling and locking screws and basecovers, and grounding connection, finished to match luminaire.

G. Concrete pole bases shall be cast-in-place reinforced concrete as indicated with anchor bolts and conduit entries as per manufacturer. Concrete shall be rated 3,000 PSI at 28 day test.

H. Concrete:
   1. Concrete for electrical requirements shall be at least 3,000 psi concrete with 1-inch maximum aggregate conforming to the requirements of Division 03 for Cast-In-Place concrete.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Refer to Section 26 27 00, Part 2.02, for wiring and splicing requirements.

B. Underground cable installation shall conform to National Electrical Code except as otherwise specified or indicated.

C. Contractor Damage: The Contractor shall promptly cause repairs to be made to any indicated utility lines or systems damaged by his operation.

D. Under roads and paved areas, ducts shall be EPC-80-PVC polyvinyl chloride conduit.

E. Cables shall be in one piece without splices between connections except where the distance exceeds the lengths in which the cable is furnished.

F. Bends in cables shall have an inner radius of not less than 12 times the cable diameter.

G. Horizontal slack of approximately 3 feet shall be left in the ground on each end of cable runs, on each side of connection and at all points where connections are to be made above ground level.

H. Earthwork: Earthwork for electrical requirements shall conform to the requirements of Division 31.

I. Coordinate work with other trades. Pre-ship anchor bolts and templates for use in preparing bases for installation. After leveling luminaires, pack grout between mounting plate and concrete footing. Provide weep holes to prevent accumulation of moisture inside pole base.

3.02 TESTS

A. Test under provisions of Section 01 40 00 and 26 05 00.

B. The Owner shall be notified at least three working days in advance of the Contractor's proposed date of the tests to permit scheduling, and to permit witnessing of the tests. The Contractor shall furnish the Owner with three copies of the results of the tests.

C. Circuits: The Contractor shall test each circuit, all controllers, and components of the system for proper operation. The Contractor shall furnish the Owner with three copies of the test results.

D. Compaction Tests: Backfill shall be tested for compaction in accordance with ASTM D1556.

E. Operating Test: Contractor shall operate the system in the presence of the Owner proving the proper operation.

END OF SECTION

SECTION 26 57 00

LOW VOLTAGE LIGHTING CONTROL SYSTEM

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

A. Furnish all labor, materials, apparatus, tools, equipment transportation, temporary construction and commissioning services as indicated on the Drawings or described in these Specifications and as required to make a complete working facility lighting control system.

B. Integrated Low Voltage Lighting Control System:
   1. The low voltage lighting control system shall consist of relay panels and digital switches.
   2. The system shall accept program changes from a handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming.
   3. Install a lighting control system consisting of relay/contactor panel(s), control switches, occupancy sensors, photocells and other controlling devices. The devices are connected by low voltage and line voltage wiring. The general operation of lighting and controlled loads shall include:
      a. Interior lighting: Manual switch and occupancy sensor control on/off with automatic time scheduled shut off.
      b. Scheduled on/off loads: Time on, time off by automatic time schedule with after hour override capability and shutoff.
      c. Exterior lighting: Photocell or astronomic on/time off, time on/photocell or astronomic off.
      d. Exterior security lighting: Photocell or astronomic on, photocell or astronomic off.
      e. Requirements are indicated in Section 26 27 00 for raceways and electrical boxes and fittings required for installation of control equipment and wiring.
      f. Provide CBC 2013 compliant seismic installation. See Section 26 05 00 for all certification and submittal requirements.

1.02 INCORPORATED DOCUMENTS

A. Sections 26 05 00, 26 27 00, 26 51 01 and 26 56 01, apply to all Work in this Section.

B. Refer to Section 26 51 01 for fluorescent dimming ballasts.
   1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.03 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer Qualifications: Installer shall be one who is experienced in performing the Work of this Section, and who has specialized in installation of Work similar to that required for this project.

C. Component Pre-testing: All components and assemblies are to be factory pre-tested prior to installation.

D. System Support: Factory applications engineers shall be available for telephone support.

E. NEC Compliance: Comply with NEC as applicable to electrical wiring Work.

F. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

G. UL Approvals: Remote panels are to be UL listed under UL 916 Energy Management Equipment.

H. CSA Approvals: Remote panels are to be CSA listed.

I. FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15 Subpart J for Class A application.

J. All System components shall be California Title 24 compliant, where applicable.

1.04 SUBMITTALS

A. Submit under provisions of Sections 01 33 00 and 26 05 00.
   1. Bill of Materials: Complete list of all parts needed to fully install selected System components.
   2. Shop Drawings: Submit dimensional Drawings of all lighting control system components and accessories.
   3. One Line Diagram: Submit a one-line diagram of the system configuration.
   4. Typical Wiring Diagrams: Submit typical wiring diagrams for all components including, but not limited to, relay panels, relays, digital low voltage switches, digital occupancy sensors and digital daylighting controls.

1.05 MANUFACTURERS

A. Integrated Low Voltage Lighting Control System:
   1. The basis of the specified system is the Watt Stopper Digital Lighting Management (DLM) or an equal. Any other system to be considered must submit descriptive information 10 days prior to bid.
   2. Prior approval does not guarantee final approval by the electrical engineer. The contractor shall be completely responsible for providing a system meeting this

specification in its entirety. All deviations from this specification must be listed and individually signed off by the engineer.

3. The Owner reserves the right to reject a proposed substitution based on his agent's professional judgment as to the utility, visual appropriateness, or finish of substitutions.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials in Manufacturer's original, unopened, undamaged packages with intact identification labels.

B. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by Manufacturer.

1.07 GUARANTEE AND WARRANTIES

A. All Work performed under this Section must be guaranteed to be free of defects in products or workmanship for one year after date of acceptance by Owner, unless noted otherwise in General Conditions.

PART 2 – PRODUCTS

2.01 DIGITAL LIGHTING MANAGEMENT

A. Description
   1. Lighting Control Panels shall be UL listed and consist of the following:
   2. EnclosureTub: NEMA 1, NEMA 3R, or NEMA 4 as indicated on the drawings, sized to accept an interior with 1-8 relays, 1-24 relays and six (6) four pole contactors, or 1-48 relays with six (6) four pole contactors.
   3. Cover: Surface or Flush as required, hinged and lockable and with restricted access to line voltage section. A final typed wiring schedule directory card shall be affixed to the cover's back.
   4. Interior: Barrier included for separation of high voltage (class 1) and low voltage (class 2) wiring. The interior shall include intelligence boards, power supply, mechanically latched control relays and multi-pole contactors. The interiors will include the following features:
      a. Screwless, removable, plug-in connections for all low voltage terminations.
      b. Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches, digital occupancy sensors and digital daylight sensors.
      c. Each relay shall be capable of individual ON/OFF control by a low voltage switch and/or occupancy sensor input.
      d. The system shall monitor true relay status; the relay status will be displayed at the onboard pilot LED and monitored by the system electronics.
      e. Stagger the On and OFF sequence of the relays.
      f. Heavy Duty Relays – Mechanically latching contacts with single moving part design for improved reliability. Relays to have the following characteristics:
         1) 30 amp NEMA 410 electronic ballast rated and 20 amp tungsten, rated for 50,000 ON/OFF cycles at full load. Support #12-#14 AWG solid or

stranded wire and rated for 120 and 277 volts; 20 amp NEMA 410 electronic ballast rated and 20 amp tungsten 347 volts.

2) 30 VAC isolated contacts for status feedback and pilot light indication.
3) 14,000 amp short circuit current rating.

g. Contactors shall be DIN rail mounted, four pole standard, normally open or normally closed, electrically held with 120 or 277 volt coil voltage to match panel control power voltage. Contractors shall be compatible with all lighting, ballast and HID loads and be rated for 277 volt 20 amp tungsten and 600 volt 30 amp ballast loads.

5. Power Supply: Multi-voltage transformer assembly with enough power to supply all electronics, occupancy sensors, dataline switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

2.02 GROUP, CHANNEL, SCHEDULE AND PATTERN CONTROL

A. Description
1. The lighting control panel shall support schedule, group, and photocell control functions via the network as configured using the LMCT hand held configuration tool.
2. Group Status: Each group pushbutton shall include an LED status indication. The LED will be ON whenever all of the relays within the group are ON; and shall go OFF when all of the relays within the group go OFF. The LED will be green when in a “mixed” state. Each channel shall also have an associated dry contact closure and pilot contact which tracks the LED operation described above.

B. Features
1. Individual relays may be assigned to more than one channel, and the channel status will be annunciated appropriately.
2. Each channel shall also have an input for connecting switch or dry contacts for controlling a channel. Inputs shall accept 2 or 3-wire maintained or momentary inputs, and groups may be controlled by: an on-board group pushbutton switch, low voltage switch, digital switch, digital occupancy sensor, digital photocell, or time of day.
3. Screwless, removable, plug-in terminals will be provided for all low voltage wiring connections.

2.03 NETWORK CLOCK

A. Description
1. Integral system clock shall provide scheduling capabilities.
2. Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.
3. The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.

4. The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.
5. The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.
6. Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.
7. The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:
   a. Scheduled ON / OFF
   b. Manual ON / Scheduled OFF
   c. Astro ON / OFF (or Photo ON / OFF)
   d. Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

B. Features
1. Runs event-based schedule routines independently (does not require BAS or Segment Manager).
2. Supports astronomical, time-based event types
3. Retains memory and time for a minimum of 10 years.

2.04 DIGITAL SWITCHES / DIMMERS

A. Description
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Load/Scene Status LED on each switch button with the following characteristics:
   a. Bi-level LED
   b. Dim locator level indicates power to switch
   c. Bright status level indicates that load or scene is active
5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.
7. Two RJ-45 ports for connection to DLM local network.
8. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

B. WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.05 DIGITAL OCCUPANCY SENSORS

A. Description
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.
2. Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
3. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
4. Digital calibration and pushbutton configuration for the following variables:
   a. Sensitivity – 0-100% in 10% increments
   b. Time delay – 1-30 minutes in 1 minute increments
   c. Test mode – Five second time delay
   d. Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
   e. Walk-through mode
   f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
5. Programmable control functionality including:
   a. Each sensor may be programmed to control specific loads within a local network.
   b. Sensor shall be capable of activating one of 16 user-definable lighting scenes.
   c. Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
   d. On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
      1) Ultrasonic and Passive Infrared
      2) Ultrasonic or Passive Infrared
      3) Ultrasonic only
      4) Passive Infrared only
6. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
7. One or two RJ-45 port(s) for connection to DLM local network.
8. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
9. Device Status LEDs, which may be disabled for selected applications, including:
   a. PIR detection

b. Ultrasonic detection
c. Configuration mode
d. Load binding

10. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
11. Manual override of controlled loads.
12. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

B. Units shall not have any dip switches or potentiometers for field settings.

C. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

D. WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.06 DIGITAL PHOTOSENSORS

A. Description:
1. Open loop digital photosensors shall include the following additional features
2. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
3. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
4. WattStopper Product Number: LMLS-500, LMLS-500-L.
5. Digital Photosensors – Single-zone closed loop, multi-zone open loop and dual-loop daylighting sensors with two-way active infrared (IR) communications can provide switching, bi-level, tri-level or dimming control for daylight harvesting.

2.07 DIGITAL ROOM CONTROLLERS AND PLUG-LOAD CONTROLLERS

A. Description
1. Open digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications.
2. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.
3. Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications

4. Multiple room controllers connected together in a local network must automatically prioritize each room controller, without requiring any configuration or setup, so that loads are sequentially assigned using room controller device ID's from highest to lowest.
5. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application-specific UL 20 rating for receptacle control.
6. Zero cross circuitry for each load
7. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
8. Device Status LEDs to indicate:
   a. Data transmission
   b. Device has power
   c. Status for each load
   d. Configuration status

B. On/Off Room Controllers shall include:
   1. One or two relay configuration
   2. Efficient 150 mA switching power supply
   3. Three RJ-45 DLM local network ports with integral strain relief and dust cover
   4. WattStopper product numbers: LMRC-101, LMRC-102

C. On/Off/Dimming enhanced Room Controllers shall include:
   1. Real time current monitoring
   2. Multiple relay configurations
      a. One, two or three relays (LMRC-21x series)
      b. One or two relays (LMRC-22x series)
   3. Efficient 250 mA switching power supply
   4. Four RJ-45 DLM local network ports with integral strain relief and dust cover
   5. One dimming output per relay
      a. 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)
      b. Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)
      c. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.
      d. The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
      e. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.
      f. Calibration and trim levels must be set per output channel.

g. Devices that set calibration or trim levels per controller are not acceptable.
h. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

6. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
7. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
8. The following dimming attributes may be changed or selected using a wireless configuration tool:
   a. Establish preset level for each load from 0-100%
   b. Set high and low trim for each load
   c. Set lamp burn in time for each load up to 100 hours
9. Override button for each load provides the following functions:
   a. Press and release for on/off control
   b. Press and hold for dimming control
10. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222

D. Plug Load Room Controllers shall include:
1. One relay configuration with additional connection for unswitched load
2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).
3. Factory default operation is Auto-on/Auto-off, based on occupancy
4. Real time current monitoring of both switched and un-switched load (LMPL-201 only)
5. Efficient switching power supply
   a. 150mA (LMPL-101)
   b. 250mA (LMPL-201)
6. RJ-45 DLM local network ports
   a. Three RJ-45 ports (LMPL-101)
   b. Four RJ-45 ports (LMPL-201)
7. WattStopper product numbers: LMPL-101, LMPL-201.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Description
1. Digital Switches and/or photocells shall be mounted in the spaces as indicated on the Drawings. Each low voltage wire shall be labeled clearly indicating which relay panel it connects to. Use only Watt Stopper pre-terminated LMRJ series Cat 5e cable as indicated on the Drawings. All relays and switches shall be tested after installation to confirm proper operation and the loads recorded on the directory card in each panel.
2. The relay panels shall be mounted in electrical closets as indicated on the Drawings. The numbered relays in the panel shall be wired to control the power to

each load as indicated on the Panel Wiring Schedules included in the Drawings. All power wiring shall be identified with the circuit breaker number controlling the load. If multiple circuit breaker panels are feeding into a relay panel, wires shall clearly indicate the originating panel's designation.

3.02 PRE-INSTALLATION MEETING

A. Manufacturer shall provide a factory authorized representative to provide a functional overview of the lighting control system prior to products being installed.
   1. Discuss functionality and integration of all products per design requirements.
   2. Confirm location of occupancy sensors and photocells as required.
   3. Confirm low voltage control wires meet specification.
   4. Explain adjustment options and verify specification requirements for each device.

3.03 PROGRAMMING

A. Set / program lighting controls per relay schedules on drawings, with input from owner for exact times required for each operation.

B. All programming shall comply with Title 24 requirements (i.e. automatic control and override limits).

C. For relays controlling halogen and metal halide lamps, a minimum 15 minute off period is required per day to mitigate potential for non-passive end of life failure. Review programming schedules and program this off-cycle for relays otherwise scheduled for continuous operation. Coordinate timing of off-cycle with Owner.

D. Test all programming for proper operation of each relay at scheduled times.

3.04 SYSTEM STARTUP

A. The Manufacturer shall provide a factory authorized technician to commission and confirm proper installation and operation of all system components.

B. Contractor shall provide system documentation after the equipment has been installed:
   1. Lighting control operational summary sheet.
   2. Programming record sheet.
   3. System Installation and Operation Manual shall be provided to the owner.

3.05 TRAINING

A. Manufacturer shall provide factory authorized application engineer to train Owner personnel in the operation and programming of the lighting control system for the first (2) two days of occupancy; then (1) one week later, and again (1) month later.

3.06 TESTS

A. Test under provisions of Section 26 05 00 and 26 08 00.

B. The Owner shall be notified at least three working days in advance of the Contractor's proposed date of the tests to permit scheduling, and to permit witnessing of the tests. The Contractor shall furnish the Owner with three copies of the results of the tests.

C. Circuits: The Contractor shall test each circuit, all controllers, and components of the system for proper operation. The Contractor shall furnish the Owner with three copies of the test results.

D. Operating Test: Contractor shall operate the system in the presence of the Owner proving the proper operation of the system and all components.

END OF SECTION

PART 1 - GENERAL

1.1 Summary

A. Section includes:
1. Common standards and procedures for the Communications Work.
2. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of the work of this Division. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction.

B. Provisions of this Section apply to Communications Work, including the following Sections:
1. Section 27 05 26 – Grounding and Bonding for Communications Systems
2. Section 27 05 29 – Hangers and Supports for Communications Systems
3. Section 27 05 33 – Conduits and Backboxes for Communications Systems
4. Section 27 05 36 – Cable Trays for Communications Systems
5. Section 27 05 43 – Underground Ducts and Raceways for Communications Systems
6. Section 27 05 48 – Noise and Vibration Controls for Communications Systems
7. Section 27 05 53 – Identification for Communications Systems
8. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
9. Section 27 11 13 – Communications Entrance Protection
10. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
11. Section 27 11 19 – Communications Termination Blocks and Patch Panels
12. Section 27 11 23 – Communications Cable Management
13. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
14. Section 27 13 00 – Communications Interior Backbone Cabling
15. Section 27 14 00 – Communications Outside Plant Backbone Cabling
16. Section 27 15 00 – Communications Horizontal Cabling
17. Section 27 41 16 – Integrated Audio-Video Systems and Equipment
18. Section 27 41 23 – Communications Broadband Systems

1.2 References

A. Usage: In accordance with Section 01 42 00 – References.

B. American National Standards Institute (ANSI)
1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009
2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October, 2008.
5. ANSI/TIA-569-C (2012) Telecommunications Pathways and Spaces

6. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure
7. ANSI/TIA-607-B (2011), Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
8. ANSI/TIA-758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.

C. BICSI
1. Telecommunications Distribution Methods Manual (TDMM) - 12th edition.
2. BICSI - Outside Plant Design Reference Manual (OSPDRM) - 4th edition.
3. BICSI - Wireless Design Reference Manual (WDRM) - 3rd edition.

1.3 Definitions

A. See also Section 01 42 00 - References

B. General Abbreviations used in these specifications. Refer additionally to the abbreviations list appearing on the Drawings.
1. ADA Americans With Disabilities Act.
2. AFC Above Finished Ceiling.
3. AFF Above the Finished Floor.
4. BDF Building Distribution Frame – see Telecommunications Rm. description below
5. BLDG Building
6. CAT Category
7. CD Campus Distributor – see Telecommunications Rm.description below
8. CL Centerline
9. dBm Decibel Power Level reference
10. DIV Division
11. (E) Existing
12. FBO Furnished By Owner
13. FD Floor Distributor – see Telecommunications Rm. description below
14. GE Grounding Equalizer – Part of the Telecommunications Grounding System
15. HR Home Run
16. ID Inside Diameter
17. IDF Intermediate Distribution Frame – see Telecommunications Rm
18. LAN Local Area Network
19. MAX Maximum
20. NIC Not In Contract.
21. OD Outside Diameter
22. OFE Owner Furnished Equipment.
23. PSRH Project Standard Receptacle Height.
24. PSSH Project Standard Switch Height.
25. TBB Telecommunications Bonding Backbone – Part of the Telecommunications Grounding System
26. TGB Telecommunications Ground Busbar
27. TMGB Telecommunications Main Ground Busbar

28. TR Telecommunications Room – see Communications Room description below – these terms are used interchangeably in this document
29. TYP Typical
30. UON Unless Otherwise Noted.

C. Electrical and electronics terms used in the Communications Sections shall be as defined in:
1. ANSI/TIA-568-C.0
2. ANSI/TIA-568-C.1
3. ANSI/TIA-568-C.2
4. ANSI/TIA-568-C.3
5. ANSI/TIA-569-C
6. ANSI/TIA-606-B
7. IEEE Std 100
8. This Section.

D. Campus Distributor (CD) - A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

E. Communications Rooms. Collectively the CD, BD/BDF, TR, EF and ER spaces of the Project.

F. Building Distributor (BDF) - A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

G. Floor Distributor (FD) - A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).

H. Telecommunications Room (TR) - An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

I. Entrance Facility (EF) (Telecommunications) An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

J. Entrance Room (ER) (Telecommunications) - A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

K. Open Cable - Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is open to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

L. Open Office - A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

M. Pathway - A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 Submittals

A. Comply with Section 01 33 23 – Shop Drawings, Product Data and Samples and the following.
   1. Submit all materials for review arranged in same order as Specifications, individually referenced to Specification Section, Paragraph and Contract Drawing number. Conform in every detail as applies to each referencing Section.
   2. Submit 8 ½"x 11" items bound in volumes and drawings in edge bound sets. Submit all drawings on sheets of the same size.
   3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
   4. Progress Schedule: Comply with Section 01 32 00 - Construction Schedules.

B. Contractor and Key Personnel Experience.
   1. A minimum of 30 days prior to installation, submit documentation of the experience of the low voltage systems, equipment and infrastructure contractor(s) and of their key personnel.
   2. Qualifications shall be provided for:
      a. the structured cabling systems, equipment and infrastructure contractor(s),
      b. the structured cabling systems, equipment and infrastructure installers,
      c. the audiovisual systems, equipment and infrastructure contractor(s),
      d. the audiovisual systems, equipment and infrastructure installers,
      e. and the supervisor(s) (if different from the installers).
   3. Refer to Quality Assurance paragraph in this section for complete requirements.

C. Manufacturer's Product Data:
   1. Manufacturer's Product Data Sheets. Collate in sequence of List of Materials:
   2. Data sheet for each item in each Communications Section, including all accessories, clearly marked for proposed product.
   3. Material Safety Data Sheet, where applies.
   4. List of Materials Schedule. For each item, include:
      a. Referencing Specification Section
      b. Referencing Paragraph
      c. Referencing Drawing, if specified only on plans
      d. Manufacturer.
      e. Model number.
      f. Listing, including name of Nationally Recognized Testing Laboratory.
      g. Precede each submittal book with a summary schedule, with columns for each item above and rows for each item submitted, per the example schedule below:

Specification Section	Paragraph	Contract Drawing Reference	Manufacturer	Model No.	UL/CLA Listed
27 05 00	2.03 C.		XYZ	123	Y
27 05 33	2.07 A. 1.		AAA	34-56	Y
		T7.2	ZZY	456	Y

D. Field (Installation) Drawings
   1. General
      a. Drawings shall present the proposed installation using the makes and models of devices proposed for use this project; if “equal” is used in bid set replace with the actual part numbers to be installed or provide a lookup table in the drawings to permit determining the actual part number.
      b. Where the existing systems and/or infrastructure are used and integrated into the work of the project, indicate them on drawings, including points of interface and demarcation of existing and new work.
      c. Collate, in sequence, at least the following minimum drawings, for each infrastructure and system to be installed under the work of this contract:
   2. Drawing index/symbol sheet.
   3. Site plans, floor plans and reflected ceiling plans.
      a. General
         i. The identifier for each termination and cable shall appear on the drawings, either directly on the floor plans, through an associated schedule or a unique identifier associated with a fully annotated single line diagram.
         ii. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.
         iii. At scale of Contract Documents, show:
            1. Device locations and type
            2. Rough-in.
            3. Mounting height.
            4. Conduit size.
            5. Basket tray routes or equivalent means of support used by the work of this project.
            6. J-hook routes
            7. Wire type.
            8. Wire fill.
         iv. On the floor plans, indicate floor and wall mounted devices and pathway below a height of 7 feet above finish floor. Indicate the locations of the Telecommunications rooms and provide reference to the enlarged Telecommunications rooms plans.
         v. On the reflected ceiling plan, indicate ceiling and wall mounted devices and pathway above a height of 7 feet above finish floor. Indicate the locations of the Telecommunications rooms and provide reference to the enlarged Telecommunications room plans.
      b. Communications Infrastructure
         i. Provide Registered Communications Distribution Designer (RCDD) approved, drawings depicting a complete communication infrastructure in accordance with ANSI/TIA-606-B. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the Telecommunications rooms including EF, ER, CD's, BD's, and FD's to the Telecommunications work area outlets.

ii. The following drawings shall be provided as a minimum:
1. T1- Layout of complete building per floor - Backbone and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of Telecommunications rooms, physical access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.
2. T-2 Serving Zones/Building Area Drawings - Drop Locations. Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. Audiovisual Systems, including MATV Systems, Audiovisual Systems and Public and Mass Notification Systems
i. Indicate:
1. Device locations, orientation and depict integration of systems that need to be viewed from the complete building perspective.
2. For distributed speaker systems, indicate limits of zones of coverage.
3. Vertical and horizontal pathways
4. Equipment rooms and racks
5. Reference to enlarged plans and related details.

4. Enlarged Plans
a. General
i. Indicate at least as much information as is provided in the Contract Documents, supplemented by the dimensions and arrangement of the proposed equipment, trade coordination and field conditions.

b. Communications Infrastructure.
i. Telecommunications Room Drawings
1. Provide T3 drawings in accordance with ANSI/TIA-606-B that include Telecommunications rooms plan views, pathway layout (cable tray, racks, ladder-racks, etc.), mechanical/electrical layout, and cabinet, rack, backboard and wall elevations. Include rack details, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.
2. At scale of Contract Documents, the Contractor shall submit scaled drawing elevations (showing dimensions, mounting locations and associated frames & equipment) for all required assemblies, including but not limited to:
a) Rack locations
b) Wall mounted plywood backboards
c) Wall mounted backbone cabling and major station cable bundles.
d) Wall mounted and tray mounted splice cases
e) Wall mounted copper cable protectors and terminal blocks.
f) Wall mounted fiber optic cable terminations.
g) Clearances

h) Backboard Wire and Cable Management
i) Rack elevations, including
j) Copper cable patch panels.
k) Fiber optic cable patch panels.
l) Rack mounted wire managers
m) Hold clears for equipment provided by Others.
n) Reference to mounting details.
o) Power strips & PDU's
p) Rack Mounted UPS.
q) Drawings may also be an enlargement of a congested area of T1 or T2 drawings.
r) Audiovisual Systems, including MATV Systems, Audiovisual Systems and Public and Mass Notification Systems

ii. At equipment rooms
1. Rack elevations, showing
a) all equipment occupying the actual number of rack units required
b) blank panels
c) vent panels
d) aux panels
e) power strips
f) UPS
g) Reference mounting details.

5. System Riser Diagrams,
a. General:
i. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment.
ii. Single line diagram of structured wiring
iii. Grounding and bonding scheme
iv. Terminal cabinets.
v. Coordination with floor plans.
vi. Wire runs not shown on floor plans.
vii. Wire type.
viii. Wire fill.
ix. Interface to work provided by work of other Sections, Owner Furnished Equipment, existing equipment and/or future equipment.
x. For Audiovisual Systems, including MATV Systems, Audiovisual Systems and Public and Mass Notification Systems, indicate digital or analog signal type and voltage levels (dBmV, microphone, line level, speaker level) or optical signal levels.

6. Detail Drawings
a. Mounting details:
i. Specific details of restraints including anchor bolts submitted under the Section 27 05 29 – Hangers and Supports for Communications Systems for mounting and maximum loading at each condition, showing compliance and coordination with Code and the project Architectural, Structural and Mechanical Documents.
ii. Stamped and signed by a Professional Engineer licensed in the Project jurisdiction for work of this type.
1. Submit an accompanying Engineering analysis stamped and signed by an Engineer licensed in California for work of this type, indicating that the Equipment Enclosure System will comply with California Building Code for the Project Seismic Zone when loaded with the weight of the equipment submitted as well as the Owner's proposed equipment intended for installation in the racks installed under the work of this Project.
2. Show calculations on drawings or in bound volume for review by Authorities having jurisdiction.
iii. Show loads, type and strength of connections, sizes, dimensions, materials, etc.
iv. Provide details for:
1. Equipment Rack anchorage.

2. Wall Mounted Racks and Enclosures.
3. Cable Runway and Cable Tray
4. Monitors
5. Projectors
6. Screens
7. Wall and ceiling loudspeakers weighing 20 pounds or more.

b. Faceplate and Receptacles
   i. Receptacle and jack arrangement for each condition.
   ii. Labeling of receptacle/jacks and plate
   iii. Plate material.
   iv. Plate finish.
   v. Connector types.
   vi. Connector dimensioned layout.

c. Pathway
   i. Cable tray installation details, indicating complete system of fittings and radiussed pathways provided.
   ii. Firestopping. Listed fire stop system documentation supporting proposed systems ability to conform with the project requirements.
   iii. Penetrations. All conduit and piping wall, ceiling, floor, and roof penetrations, be they fire rated or not, should be submitted for review prior to installation.
      1. For cored penetrations through concrete partitions, submit proposed work plan in the form of Coring/Sawcutting Summary Description as described in Section 27 05 33 – Conduits and Backboxes for Communications Systems.
   iv. Details of flexible raceway connections to be made to vibrating equipment
   v. Details of J-Box and sealant application for the typical conditions listed in Section 27 05 48 – Noise and Vibration Controls for Communications System, and a schedule of rooms to receive application of mastic and sealant at J-Boxes

vi. An itemized list of all items of equipment to be fitted with flexible electrical connections.
vii. Conduit racking details.

d. California Access Compliance Manual and Americans with Disabilities Act (ADA) compliance.

e. For systems with contractor or manufacturer programmed control and human interfaces submit at least:
   i. Narrative of the sequence of operation.
   ii. Color, full-size layouts of each touchpanel and/or computer screen (menu) image, cross-referenced to the sequence of operations.
   iii. Show chaining of sub-menus.

f. Terminal cabinets: Terminations.

E. Schedule Submittals.
1. An Excel spreadsheet listing jack number, floor number, room number and jack type (workstation, wireless, camera, emergency phone, etc.)
2. Voice cable plant: Cut sheets for use by Owner's Telephone Systems Contractor

F. Samples: Samples for review by the Owner's Representative of all finishes/materials which will be visible to the public, including but not limited to:
1. Receptacles. The Contractor shall submit a mock up sample of each type of communication outlet including conduit, wall box, faceplate, communication cables, jacks and jack identifying labels.
2. The Contractor shall submit a sample of each type of label to be used for labeling cables, patch panels, termination frames, and faceplates for the telephone and data systems.
3. Surface Raceway, for each type:
   a. Raceway base and cover, at least 5 foot section.
   b. Boxes, at least two of each type to be used.
   c. For other items, provide at least 2"x 2" sample.

G. Test Plan
1. Submit complete documentation of the proposed test plan and equipment to be used to document that the performance of the cabling, equipment, sub-systems and complete systems installed under the work of this project conform with the performance standards outlined in each specification section.
2. Submit not less than 45 days prior to the proposed test date. Include procedures for certification, validation, and testing.
3. Structured Cabling Test Plan
   a. Submit complete documentation of the proposed test plan and equipment to be used to document that the performance of the cabling, equipment, sub-systems and complete systems installed under the work of this project conform with the performance standards outlined in each specification section.
   b. Submit not less than 45 days prior to the proposed test date. Include procedures for certification, validation, and testing.
   c. Submit manufacturer's or recognized national test laboratory’s calibration certificate one (1) month before any post-installation testing begins. Date on test unit calibration certificate shall be no longer than one (1) year prior to the date that post-installation testing is scheduled to begin.

d. Submit a copy of the Test Equipment manufacturer's recommended testing procedure for each of the structured cabling system elements listed above in this section.

H. Test Reports
1. Manufacturer's Field Reports
a. Factory reel tests
2. Project Site Test Reports:
a. Submit following system completion and prior to and as condition precedent to Acceptance Review and Testing of the Work of this Section.
b. Schedule: Submit test reports in timely manner relative to Project schedule such that the Owner's Representative may conduct verification of submitted test data without delay of scheduled progress.
c. Project Site test report:
d. Content: Include at least:
i. Time and date of test.
ii. Personnel conducting test.
iii. Test equipment, including serial and date of calibration.
iv. Test object.
v. Procedure used.
vi. Results of test
vii. Numerical or graphical presentation.
e. Submit copy of final results on paper and in electronic form. This shall be organized by cable ID number for the circuit under test, consistent with circuit numbering scheme used in preparing submittal drawings and in labeling receptacles and terminations.
i. Submit machine-generated documentation and raw data of all test results in electronic form on DVD media.
ii. Submit machine-generated documentation of all test results in printed form organized in binders for each category of test performed.

1.5 Quality Assurance

A. Procedures: In accordance with Section 01 40 00 – Quality Requirements.

B. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

C. Reference Documents: At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies.
1. A complete set of the latest stamped, actioned submittals of record.
2. A complete set of manufacturer's original operation, instruction and service manuals for each equipment item.

D. Standard Products

1. Telecommunications Equipment. Provide telecommunications materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship.
    a. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
    b. Alternative Qualifications. Products having less than a 1-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
2. Audiovisual Systems Equipment. Provide Audiovisual Systems materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for six months prior to bid opening. The six month period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the six month period.
    a. Alternative Qualifications. Products having less than a 1-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 2500 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
3. Identical Products
    a. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the specifying section.
4. Material and Equipment Manufacturing Date
    a. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

E. Test Equipment
1. Requirements:
    a. Maintain and operate test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section.
    b. Maintain test equipment at the job site while work is in progress from installation of equipment racks until Owner 's Acceptance of this Work; thereafter remove all of this test equipment from the job site.
    c. Unless otherwise indicated, test equipment shall remain property of the Contractor.
    d. Provide all required test cables, jigs and adapters.
    e. Provide equipment with traceable calibration, with calibration date not greater than one year prior to the date of the use of the equipment to perform the specified testing.

F. Qualifications
1. Key Personnel, General
a. Indicate the proposed key persons that are currently employed by the telecommunications contractor or who have a commitment to the low voltage systems and infrastructure contractor for the work of this project. All key persons shall be employed by the low voltage systems and infrastructure contractor at the date of issuance of this project, or if not, have a commitment to the low voltage systems and infrastructure contractor to work on this project by the date that the bid was due to the Owner's Representative.
b. Note that only the key personnel approved by the Owner's Representative in the successful proposal shall perform work on this project's low voltage systems and infrastructure systems. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the low voltage systems and infrastructure contractor's key personnel requires approval from the Owner's Representative.
2. Telecommunications Contractor
a. The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment.
i. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years.
ii. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations of comparable project size and complexity completed successfully by the telecommunications contractor.
b. Key Personnel
i. Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this project depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.
ii. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.
iii. In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system

installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this project. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this project. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

1. Indicate that all key persons are currently employed by the low voltage contractor, or have a commitment to the low voltage contractor to work on this project. All key persons shall be employed by the low voltage contractor at the date of issuance of this project, or if not, have a commitment to the low voltage contractor to work on this project by the date that the bid was due to the Owner's Representative.
2. Note that only the key personnel approved by the Owner's Representative in the successful proposal shall perform work on this project's low voltage systems, equipment and infrastructure. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the low voltage contractor's key personnel requires approval from the Owner's Representative

3. Minimum Communications Infrastructure Manufacturer Qualifications
   a. Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with ANSI/TIA/EIA-568-C.1, ANSI/TIA/EIA-568-B.2 and ANSI/TIA/EIA-568-C.3.
4. Audiovisual Systems Contractor
   a. The installer of the audiovisual systems shall be a firm regularly and professionally engaged in the business of installation, configuration and testing of the specified audiovisual systems and equipment.
      i. Where the manufacturers of the specified and contractor proposed systems provide mandatory installer and programming training programs, the Contractor's programming and installation staff shall provide documentation to demonstrate their successful completion of the relevant training programs for the types and versions of equipment proposed for installation on this Project.
      ii. Where the manufacturer of the specified and contractor proposed systems and equipment lawfully restricts sales of their equipment to a network of dealers, the contractor shall provide documentation to

their standing as such a dealer in good standing at the time of bid submittal.

iii. The audiovisual systems contractor shall demonstrate experience in providing successful audiovisual systems of a similar scope and nature of those required by the work of this Project within the past 3 years.

iv. Submit documentation for a minimum of three and a maximum of five successful audiovisual system installations of a comparable size and complexity completed successfully by the audiovisual systems contractor.

b. Key Personnel

i. Provide key personnel who are regularly and professionally engaged in the business of the installing, programming, configuring and testing of the specified audiovisual systems and related presentations and equipment.

1. There may be one key person or more key persons proposed for this project depending upon how many of the key roles each has successfully provided.
2. Each of the key personnel shall demonstrate experience in providing successful audiovisual systems of a similar nature scope and extent to those required by the work of this Project within the past 3 years.
3. Provide specific documentation indicating that the proposed key personnel have obtained factory sponsored training and certification in the programming, configuration and adjustment of the software based controls and audiovisual systems equipment required by the work of this Project. Provide documentation demonstrating current certification of proposed personnel conforming with the requirements of this Section.

1.6 Regulatory Requirements

A. Regulations Applicable: Including but not limited to those defined in Section 01 41 00 - Regulatory Requirements.

1. Nothing in the Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, or regulations.
2. Safety Agency Listing: All devices provided under the Work of this Section which are connected to the Project electrical system shall be listed by a Nationally Recognized Testing Laboratory, and shall be so labeled.
3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner's Representative. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.7 Delivery, Storage and Handling

A. Procedures:

1. In accordance with Section 01 61 00 – Product Requirements and as specified in the individual sections of Division 27.

B. General
1. Protect materials and equipment from damage during delivery, storage, handling and throughout the staging and construction periods. Equipment and materials shall be protected against physical damage, dirt, theft, sun, moisture (including surface water and precipitation) and extreme temperature.
2. The top and bottom ends of all cable shall be available for testing. When not being prepared for testing, both ends of each cable shall be sealed to prevent the ingress of moisture.
3. Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.
4. Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.
5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
6. As determined by the University's Representative, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. The decision of the University's Representative shall be final.
7. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
8. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer

1.8 Environmental Requirements

A. Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, non-condensing.

1.9 Sequencing

A. Comply with Section 01 11 00 - Summary of Work, Section 01 32 00 – Contract Schedules and the following.
1. Sequence.
   a. If there are any modifications to the bid documents, the Owner will provide the Contractor copies of the Contract Drawings showing station outlets with final Owner assigned backbone cable and horizontal jack and cable ID numbers in the following form.
2. Reproduceables:
   a. CAD files: 1 set.
3. Contractor to use these numbers in preparing their shop drawings and in executing the work of the Project.

1.10 Operating and Maintenance Data

A. Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the low voltage systems, equipment and infrastructure work of this Project. Precede the manuals with a systems narrative specific to this Project, outlining the major systems functionality, the major systems components, and identifying which manuals document the performance of which subsystems.
   1. Submit operations and maintenance data in accordance with Section 01 78 00 - Closeout Submittals and as specified herein not later than 2 months prior to the date of beneficial occupancy.

1.11 Project Record Documents

A. Comply with Section 01 78 00 - Closeout Submittals and the following. Include at least as much information as required for the submittal drawings.
   1. Record Drawings
      a. Content, General
         i. Contractor shall be responsible for updating building and communications plans to reflect as-built and as-installed conditions.
         ii. Indicate actual work on Drawings; indicate actual products used, replace vendor neutral nomenclature used in bid set with makes and models of actual installed devices.
         iii. Record drawings are to be updated depicting the cables used and the new designations resulting from the installation. These are also to be updated on the Owner's campus outside plant communications map. The Owner's Representative will provide a copy of the current file for the Contractor to update - the content of which may differ from the simplified form used in the contract documents.
      b. Additional Content, Telecommunications Infrastructure
         i. Provide T5 drawings including documentation on cables and termination hardware in accordance with ANSI/TIA-606-A. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. Provide the following T5 drawing documentation as a minimum:
            1. Cables - A record of installed cable shall be provided in accordance with ANSI/TIA-606-B. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with ANSI/TIA-606-B. Include manufacture date of cable with submittal.
            2. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with ANSI / TIA-606-B. Documentation shall include the required data fields as a minimum in accordance with EIA TIA/EIA-606-B.

ii. Where work of this project installs Owner furnished wireless access points, provide the complete spreadsheet documentation required under Section 27 05 53 - Identification for Communications Systems.

c. CAD.

i. Use a computer aided drafting (CAD) system in the preparation of record drawings for this Project. CAD system shall produce files in AutoCAD® .DWG format, latest version at time of bid. (Owner Standard, no substitution permitted).

ii. Except where prohibited by Contract, Owner's Representative will furnish CAD backgrounds in AutoCAD® .DWG format, for use by the Contractor in preparing Record Drawings.

1. At minimum, the Project Record drawings to document the following:

a) All cabling outlets with IDs for each connector on the faceplate;

b) Two inch (2”) and larger conduit pathways to include conduit size label;

c) Pull box locations;

d) Two inch (2”) & four inch (4”) J hook runs indicated by a line series of “x”s;

e) Telecom room layout labeled per current construction drawing field mark-ups;

f) Rack elevation labeled per current construction drawing field mark-ups;

g) Backbone copper and fiber schematic drawings with labeling information

iii. Disk copy of Record Drawings: Provide 2 separate disc copies of each drawing file in the format noted above. Submit on CD-R disk media.

d. Reproducibles: As required in Section 01 78 00.

e. Provide at least a copy of software with at least 1 user license if required to view submitted test data.

2. Software

a. Controls and DSP Systems

i. Provide licensing for project specific software programming at programmable devices.

ii. Provide licensing and original software copies for each device provided that uses software for operation, configuration or control.

iii. Provide licensing for required workstation operating systems, and required third party software.

iv. For controls systems, provide a complete copy of the source code, including the device interface driver code modules.

v. Upgrade each software package to the release in effect at the end of the Warranty Period.

b. Provide at least a copy of software with at least 1 user license if required to view submitted test data.

3. Spare Parts

a. In addition to the requirements of 01 78 00 - Closeout Submittals provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

1.12 Warranty Service

A. In addition to provisions of 01 78 36 – Warranties, provide the following.
   1. Response Time: Provide a qualified technician familiar with the work at the Project Site within 4 hours after receipt of a notice of malfunction. Provide the Owner's Representative with telephone number attended 10 hours a day, 5 days a week, to be called in the event of a malfunction.
B. Provide all additional Warranties as defined in each Communication Systems Section.

1.13 Acceptance Review and Testing Procedures

A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Owner's Representative in writing that the Work of these Sections is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing. The Owner's Representative will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These procedures may be performed at any hour of the day or night as required by the Owner's Representative to comply with the Project Schedule and avoid conflict with Residents. Provide all specified personnel and equipment at any time without claim for additional cost or time.
B. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this Section. Provide quantity of technicians as required to comply with Project Schedule.
C. In Addition, Provide:
   1. All tools appropriate for performance of adjustment of and corrections to this Work. Include spare wire and connectors and specified tooling for application.
   2. Ladders, scaffolding and/or lifts as required to access high devices.
   3. All test equipment.
   4. Complete set of latest stamped, actioned submittals of record for reference.
   5. Complete set of Test Reports.
   6. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
   7. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
   8. Adjust: As directed by the Owner's Representative.
   9. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the Owner's Representative.
D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner's Representative, in place of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven (7) days prior to the scheduled completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

1.14 Closeout

A. In addition to provisions of Section 017 7 00 - Closeout Procedures, Section 01 78 00 - Closeout Submittals and Section 01 79 00 Demonstration and Training, provide the following:
   1. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify the Owner's Representative of completion of Punch List.
   2. Portable Equipment: Furnish all portable equipment and spares to the Owner's Representative, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
   3. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.
   4. Project Record Documents: Submit print and digital copies. Digital files shall be CAD system files in AutoCAD® .DWG format, latest version at time of bid. (Owner Standard, no substitution permitted) as defined above.
   5. Keys: If applicable, replace construction locks with permanent locks. Provide 5 sets of keys to the Owner's Representative.
   6. Instruction: Conduct specified instruction.
   7. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

PART 2 - PRODUCTS

2.1 General

A. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.

B. Each material, device or piece of equipment shall comply with all of the manufacturer's current published specifications for that item.

C. Products shall be made by manufacturers regularly engaged in the production of such products.

D. Provide quantity as shown on Contract Drawings, or as otherwise indicated.

E. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.

F. Unless recycled content is specified, provide new materials.

G. Provide the manufacturer's latest design/model, permanently labeled with the manufacturer's name, model number and serial number.

H. Where products are of similar type or use, provide products of the same manufacturer, unless otherwise indicated.
   1. When more than one unit of the same type of equipment or material is required, such units shall be the products of a single manufacturer and part number.

I. Components
   1. UL or third party certified. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.
   2. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance.
      a. The label or listing by the specified organization will be acceptable evidence of compliance.
      b. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Owner's Representative.
      c. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.

J. Enclosures:
   1. Provide steel frames and enclosures designed and wired to eliminate all induced currents.
   2. Make bolted connections with self-locking devices.

K. Finishes: Any item or component of the Work of this Section which is visible shall comply with the following.
   1. Finishes noted or scheduled on the Contract Drawings take precedence.
   2. Where design location requires that products, materials or equipment are visible to the public, no manufacturer's logos larger than 1/2 inch shall be visible. Unless otherwise noted or directed, neatly remove or permanently paint out such logos.
   3. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Owner's Representative.

PART 3 - EXECTUTION

3.1 Examination

A. Examine existing conditions before starting work. Submit conflicts in a timely manner for resolution

3.2 Wiring Classification and Related

A. Audio Signal Wiring Classification:
   1. Type A-l: Microphone level wiring less than -30 dBu, 20 Hz to 20 kHz.
   2. Type A-2: Line level wiring -30 dBu to +24 dBu, 20 Hz to 20 kHz.
   3. Type A-3: Loudspeaker level or circuit wiring greater than +24 dBu, from 20 Hz to 20 kHz.

B. Video and Related Signal Wiring Classification:
   1. Type V-1: Baseband and composite video wiring 1 volt peak-to-peak into 75 ohms, 0 to 10.0 MHz.

2. Type V-2: Synchronization and switching pulse wiring 4 volts peak-to-peak into 75 ohms, 15.62 to 15.75 kHz.
3. Type V-3: Color subcarrier wiring 0 to 4 volts peak-to-peak into 75 ohms, 3.57 to 4.43 MHz.
4. Type V-4: MATV system wiring 0.1 to 1000 microVolts peak-to-peak into 50 or 75 ohms, 47 to 890 MHz.

C. Control Signal Wiring Classifications:
1. Type C-1: DC control wiring 0 to 50 volts.
2. Type C-2: Synchronous control or data wiring 0 to 40 volts, peak-to-peak.
3. Type C-3: AC control wiring 0 to 48 volts, 60 Hz.

D. Additional Wiring Classifications:
1. Type M-1: DC power wiring 0 to 48 volts.
2. Type M-2: AC power wiring greater than 50 volts, 60 Hz.
3. Wiring Combinations:

E. Except as indicated herein, conduit, wireways and cable bundles shall contain only wiring of a single classification. The following combinations are acceptable in conduit, or cable harnesses. Additional acceptable combinations may be indicated on the Drawings.
1. Types A-1, C-1, and M-1.
2. Types A-2, C-l, C-2, and M-l, runs less than 20 feet.
3. Types A-2, C-1, and M-1.
4. Types A-3, C-1, C-2, and M-1.
5. Types A-2, V-1, and V-3.
6. Types V-1, V-2, V-3, and C-1.
7. Types M-2 and C-3.

3.3 Preparation

A. Prepare and sequence the work to minimize disruption to each room environment and existing communications systems.

B. Protection: Cover all computers, electronic equipment, desks, chairs, furniture and other articles when working at ceiling level and/or performing dust producing tasks.

3.4 Repair and Restoration

A. Where working in spaces occupied by the Owner, return to their original positions any furniture or articles relocated to perform the work.

3.5 Cleaning

A. Where working in spaces occupied by the Owner:
1. Immediately after completing work within each space, clean up and remove all materials, scrap and dust.
2. All scrap material in work area shall be picked up and removed from the building at the end of each day. See also Section 01 74 00 - Cleaning for additional requirements.

3. All dust resulting from work performed shall be vacuumed up daily.
4. All scrap material shall be removed from Campus and disposed of in an authorized disposal site. Refer to 01 78 00.
5. Telecommunications Room clean-up shall be performed at time of Turn-over.
   a. Thorough Vacuuming and wipe-down of all surfaces.
   b. All unused materials removed.

END OF SECTION

PART 1 - GENERAL

1.01 Scope of Work

A. Section includes grounding and bonding of Communications Work, including but not limited to:
   1. Communications Raceways
   2. Cable Runway
   3. Cable Shields
   4. Protector Fields
   5. Communications cabinets and enclosures.

B. Related Work Under Other Sections
   1. Section 26 05 26 – Grounding & Bonding for Electrical Systems
   2. Section 27 05 00 – Common Work Results for Communications
   3. Section 27 05 29 – Hangers and Supports for Communications Systems
   4. Section 27 05 33 – Conduits and Backboxes for Communications Systems
   5. Section 27 05 39 – Surface Raceways for Communications Systems
   6. Section 27 05 36 – Cable Trays for Communications Systems
   7. Section 27 05 43 – Underground Ducts and Raceways for Communications Systems
   8. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
   9. Section 27 11 13 – Communications Entrance Protection
   10. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
   11. Section 27 11 19 – Communications Termination Blocks and Patch Panels
   12. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
   13. Section 27 13 00 – Communications Interior Backbone Cabling
   14. Section 27 14 00 – Communications Outside Plant Backbone Cabling
   15. Section 27 15 00 – Communications Horizontal Cabling
   16. Section 27 32 26 – Ring-Down Emergency Telephones
   17. Section 27 41 13 – Architecturally Integrated Audio-Video Equipment
   18. Section 27 41 16 – Integrated Audio-Video Systems and Equipment

1.02 System Description

A. Provide Telecommunications Grounding System as described herein and indicated on drawings.

B. Except as otherwise indicated, the complete communications installation including the racks, cabinets, panels, cable tray, runway, lightning protectors cable shields and splice cases provided under the work of this project shall be completely and effectively grounded in accordance with all Code and Standards requirements, whether or not such connections are specifically shown or specified.

C. Resistance:
   1. Size TBB per ANSI-J-STD-607-B-2011 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
   2. Resistance from the farthest ground bus through the ground electrode to earth shall not exceed 5 Ohms or the requirements of ANSI-J-STD-607-B-

2011, whichever is more restrictive.

3. Resistance from Communications Racks Buss ground to Ufer ground must remain less than or equal to the electrical ground presented at A/C outlet for electronic equipment in the communications rack

D. Telecommunications Bonding Backbone (TBB) and Grounding Equalizer (GE) provides direct bonding between different locations in a building, typically between ERs and TRs. The TTB shall be separate from the Electrical Bonding Backbone and only tie together at the Building Service Entrance Ground to reduce induced interference by the electrical system. A TBB is considered part of a grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure) but is independent of equipment or cable. The TBB interconnects all TGBs with the TMGB. The TBB shall be sized at minimum 3/0 AWG [14.73 mm (0.580 in)]. Whenever two or more TBBs are used within a multistory building, the TBBs are to be bonded together with a GE at the top floor and at every third floor in between. The GE is sized the same as the TBB. The sizing of the TBB.Bonding to limit potential differences is spelled out in NEC 250.58, 250.94, and 800.100(D).

1.03 References

A. American National Standards Institute (ANSI)
1. ANSI-J-STD-607-B-2011 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
2. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure

B. IEEE
1. IEEE C135.30 (1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

C. Underwriters Laboratories (UL)
1. UL 467 (1993); R 2004 Grounding and Bonding Equipment
2. Underwriters Laboratories (UL).

1.04 Submittals

A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:
1. Ground Rod:
a. High strength high carbon steel, with electrolytically bonded jacket of copper on surface
b. 5/8" diameter minimum.
c. 5' long minimum.
d. UL spec. 467
e. ANSI C-33.8-1072.

f. Manufacturer:
    i. Allied Bolt
    ii. Inwesco 12A60
    iii. Blackburn
    iv. Cooper Power Systems
    v. Weaver.
    vi. Erico "Cadweld" Products, Inc.
    vii. ITT Blackburn.
    viii. Or equal.

2. Ground Wells:
    a. Christy Concrete Products, Inc.
    b. Forni Corp.
    c. Or equal.
3. Ground Bushings, Connectors, Jumpers and Bus:
    a. O-Z/Gedney.
    b. Thomas & Betts Corp.
    c. Or equal.
4. Compression Connector Lug
    a. Panduit
    b. Harger Lightning & Grounding
    c. Or equal.
5. Telecommunications Ground Bus Bar
    a. Panduit
    b. Harger Lightning & Grounding
    c. or equal.
6. Rack and Cabinet Grounding
    a. Panduit Structured Ground Kit
    b. Harger Lightning & Grounding
    c. or equal.
7. Bonding Ribbon:
    a. Annealed solid copper 3/8 inch wide x 1/16 inch thick, tin plated.
    b. Manufacturer:
        i. Inwesco 12A55
        ii. Corning Cable Systems
        iii. Preformed Line Products.
        iv. or equal.
8. Bonding Ribbon Clamp:
    a. Soft lead
    b. 1/16 inch thick
    c. Bolt hole for attachment
    d. Manufacturer:
        i. Inwesco 12A56
        ii. Corning Cable Systems
        iii. Preformed Line Products.
        iv. Or equal.
9. Fargo Clamp:
    a. Cast copper, silver plated, furnished with copper bolt.
    b. RUS Listed
    c. Manufacturer:
        i. Allied Bolt
        ii. Inwesco 12A57

iii. Corning Cable Systems
iv. or equal.

10. Ground Inserts:
    a. Ground inserts provide a threaded point for attachment of ground wires or bonding ribbon. Inserts are flush mounted in manholes or vaults with their tails attached to rebar cage in the substructure
    b. Cast Bronze w 1/4 Copper Rod.
    c. Provide minimum two each maintenance hole.
    d. Provide minimum one each maintenance hole or vault.
    e. Manufacturer:
        i. Inwesco 12H69
        ii. or equal by vault or manhole manufacturer.
        iii. or equal.

2.02 Telecommunications Main Ground Bar (TMGB)

A. Copper ground bar, 24 inches long x 4 inches high x ¼-inch thick. Provide with mounting brackets, insulated stand-offs, and attachment hardware. Ground bar shall be provided with pre-drilled 7/16-inch hole sets on 1-inch centers, to accommodate two-hole lug attachment using the BICSI pattern.
    1. Manufacturer:
        a. Panduit GB4 series BICSI/J-STD-607-A
        b. Harger GBI14424TMGB.
        c. or equal

2.03 Telecommunications Ground Bar (TGB)

A. Copper ground bar, 24 inches long x 4 inches high x ¼-inch thick. Provide with mounting brackets, insulated stand-offs, and attachment hardware. Ground bar shall be provided with pre-drilled 7/16-inch hole sets on 1-inch centers, to accommodate two-hole lug attachment using the BICSI pattern.
    1. Manufacturer:
        a. Panduit GB4 series BICSI/J-STD-607-A
        b. Harger GBI14424TMGB.
        c. or approved equal.

2.04 Ground Conductors

A. General purpose insulated: UL listed and code sized copper conductor, with dual rated THHN/THWN insulation, color identified green.
B. Cable jacket marking:
    1. Must be legible and shall contain the following information:
        a. Manufacturer's name
        b. Copper conductor gauge
        c. UL listing
        d. Cable jacket shall be green with black lettering
C. Telecommunications Bonding Backbone Cable: 3/0 AWG THHN/THWN CU - Must be UL listed.
    1. Manufacturer:
        a. General Cable
        b. Harger Lightning & Grounding

c. or approved equal.

D. Bonding pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.

E. Bonding Conductors sized at 2 kcmil per linear foot of conductor length up to a size of 3/0 AWG ground wire.

F. Sizing of the telecommunications bonding per ANSI J-STD-607-A

TBB Length (Linear m (ft))	TBB Size (AWG)
Less than 4 (13)	6 [4.1 mm (0.16 in)]
4 to 6 (13 to 20)	4 [5.2 mm (0.20 in)]
6 to 8 (20 to 26)	3 [5.8 mm (0.23 in)]
8 to 10 (26 to 33)	2 [6.5 mm (0.26 in)]
10 to 13 (33 to 44)	1 [7.4 mm (0.29 in)]
13 to 16 (44 to 52)	1/0 [12.24 mm (0.482 in)]
16 to 20 (52 to 66)	2/0 [13.41 mm (0.528 in)]
Greater than 20 (66)	3/0 [14.73 mm (0.580 in)]

2.05 Compression Connector Lug

A. Description
1. Long-barrel compression lugs shall be used on all ground wire.
2. Copper alloy body.
3. Provide lug size to match conductor being terminated.
4. Provide 2 hole pattern lugs.
5. Provide each lug with silicon bronze hardware, including 2 bolts, 2 split lock washers and 2 nuts.

B. Manufacturer:
1. Panduit
2. Harger Lightning & Grounding GECLBxxx (xxx depending on Cable Size)
3. or approved equal.

2.06 Insulated Grounding Bushings

A. Plated malleable iron or steel body with 150 degree Centigrade molded plastic insulating throat and lay-in grounding lug.

2.07 Connections to Structural Steel, Ground Rods, or Splices

A. Where required by the Drawings or Specifications, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds or high pressure compression type connectors.
1. Exothermic welds shall be used for cable-to-cable and cable-to-ground rod and for cable to structural steel surfaces. Exothermic weld kits shall be as manufactured by Harger Lightning & Grounding, Cadweld, Thermoweld or equal. Each particular type of weld shall use a kit unique to that type of weld.
2. High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections. Connections shall be as manufactured by Thomas & Betts #53000 series, Burndy “Hy-Ground” or

equal.

2.08 Extra Flexible, Flat Bonding Jumpers

A. Two Hole Tinned Flat Braided Copper Ground Straps, 6 Gauge equivalent, 12" long with crimped lugs on each end and ¼"-20 mounting hardware.
B. Manufacturer:
   1. Harger GS12094122C3/8
   2. or equal.

PART 3 - EXECUTION

3.01 General

A. Provide Grounding and Bonding according to the most restrictive requirements of:
   1. ANSI-J-STD-607-A.
   2. California Electrical Code Article 250 and references therein.
   3. California Electrical Code Article 800.
B. In the event of conflicting requirements, National Electrical Code requirements shall prevail.
C. Point of Connection
   1. Under Work of this Section, install a complete Telecommunications Grounding System, leaving only the physical connection between the TMGB and Building Service Entrance Ground for work under Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   2. A licensed electrical contractor shall perform termination of the main bonding conductor from the TMGB to the building service entrance ground.
D. Ground Bar Installation
   1. The Contractor shall install a ground bar in each Telecom Room to which all ground wires, grounding terminal points within the room, and Telecommunications Bonding Backbone conductors will terminate.
   2. The ground bar shall be installed in a horizontal orientation at a height above finished floor and at the location indicated on the Telecom drawing for each Telecom Room.
   3. All connections to the ground bar shall use Antioxidant Joint Compound.
E. Ground And Bonding Conductor Installation
   1. Any conduit required by the Electrical Code for the installation of Bonding Conductors outside the Telecom Room to be provided under the work of Division 26.
   2. All lug connections to the ground bars and opposite end shall use Antioxidant Joint Compound.
   3. Contractor shall install a minimum 3/0 gauge bonding conductor using a 2-hole, long-barrel compression lug from the TMGB ground bar in the main Telecom Room to the main ground bar at the main building electrical service. No connection shall be made by work of this section to the electrical service ground bar. This shall be done by parties licensed to do so under the work of Division 26. There shall be no mechanical splices or mechanical couplers installed between the wire points of origin and termination.

4. Contractor shall install a minimum 3/0 gauge bonding conductor using a 2-hole, long-barrel compression lug from the TMGB ground bar in the main Telecom Room to all other TGB ground bars in each Telecom Room. There shall be no mechanical splices or mechanical couplers installed between the wire points of origin and termination.
5. Contractor shall install a minimum 3/0 gauge bonding conductor using a 2-hole, long-barrel compression lug between multiple Telecom Rooms on the Ground Floor (or 1st Floor depending on nomenclature), the top floor, and at least every third floor of a building.
6. Unless otherwise noted, all bonding and ground wires on telecom cable trays and runways shall be routed on the outer edge of the cable trays and runways.

F. Mechanical Connections
1. Make connections bare metal to bare metal.
2. Where required, remove paint to bare metal, make grounding or bonding connection, and touch up paint.
3. Torque threaded fasteners to manufacturer's recommended values.

G. Compression Connections
1. Make compression connections with the lug or fitting manufacturer's recommended tooling, with the tooling set to the recommended force and stroke.

H. Underground Communications Structure Ground Rods
1. A ground rod shall be installed at new communications handholes, vaults, manholes and pullboxes installed by the work of this Project, or at existing underground structures used by the work of this Project lacking a ground rod.
   a. Provide two ground rods at maintenance holes.
   b. Elsewhere provide one ground rod.
2. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.
3. Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths.
   a. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations.
   b. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

I. Communications Raceways and Sleeves
1. Bond metallic raceway and sleeves to the Telecommunications Ground Busbar at the Telecommunications Room that serves the related Telecommunications Receptacle.

2. Where a metallic raceway connects 2 or more Telecommunications Rooms, bond to the Telecommunications Ground Busbar at each.

J. Cable Tray and Cable Runway
1. Provide manufacturer's bonding clips, plates or jumpers as required to comply with the UL Classified conditions for use as an equipment grounding conductor.
2. Bond the Cable Runway to the Telecommunications Ground Busbar at the Telecommunications Room served.
3. Bond each section of Cable Runway with a braided copper ground strap.

K. Cable Shields
1. Comply with California Electrical Code Article 800.

L. Protector Fields
1. Comply with California Electrical Code Article 800.

M. Telecommunications cabinets and enclosures
1. Bond to the Communications Ground Busbar at the Communications Room.

N. Emergency/Information Telephone enclosures
1. Bond as detailed on Communications Drawings.

O. Communications Broadband Systems
1. Comply with California Electrical Code Article 820.
2. Ground Broadband passives as shown on Communications Drawings.

3.02 Labeling

A. Provide labeling according to the requirements of:
1. ANSI/TIA/EIA-606-B.
2. Section 27 05 53 - Identification for Communications Systems.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the provision of communications supports and cable hook system as described in this specification, including but not limited to:

1. Strut supports
2. Cable Hooks (J-hooks)
3. Beam clamps
4. Concrete Fasteners
5. Touch-Up Materials
6. Conduit supports.
7. Equipment supports.
8. Fastening hardware.

B. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1. Section 03 30 00 – Cast-in-place Concrete. Concrete equipment pads.
2. Division 5: Miscellaneous metals. Hangers for electrical equipment.
3. Section 09 51 13 – Acoustical Panel Ceilings. Slack fixture support wires.
4. Section 27 05 00 – Common Work Results for Communications
5. Section 27 05 26 – Grounding and Bonding for Communications Systems
6. Section 27 05 33 – Conduits and Backboxes for Communications Systems
7. Section 27 05 36 – Cable Trays for Communications Systems
8. Section 27 05 39 – Surface Raceways for Communications Systems
9. Section 27 05 48 – Noise and Vibration Controls for Communications Systems
10. Section 27 05 53 – Identification for Communications Systems
11. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
12. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
13. Section 27 11 23 – Communications Cable Management
14. Section 27 13 00 – Communications Interior Backbone Cabling

15. Section 27 14 00 – Communications Outside Plant Backbone Cabling

16. Section 27 15 00 – Communications Horizontal Cabling

17. Section 27 41 16 – Integrated Audio-Video Systems and Equipment

1.2 SYSTEM DESCRIPTION

A. Provide devices specified in this Section and related Sections for support of communications equipment specified for this Project.

B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.3 SEISMIC DESIGN REQUIREMENTS

A. Identify each item requiring seismic restraint installation in accordance with CBC Chapter 16A. Include floor mounted items weighing more than 400 pounds and wall mounted or suspended items weighing more than 20 pounds.

B. Supports for such items, including racks, conduit, cable trays and similar shall be provided support, bracing, and anchorage, designed by the Contractor in accordance with the following criteria:

1. Design to resist seismic forces in accordance with CBC Chapter 16A.

2. Minimum Design Parameters - As defined for the Building, with respect to Occupancy Category, Site Classification, Seismic Design Category, Importance Factor, Spectral Acceleration and SDI.

1.4 REFERENCES

A. American Institute Of Steel Construction (AISC)

1. AISC 325 (2005) Steel Construction Manual

B. American Society For Testing and Materials (ASTM)

1. ASTM A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

2. ASTM A153/A153M-04 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

3. ASTM B633-98e1 Specification for Electro-deposited Coatings of Zinc on Iron and Steel.

4. ASTM A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. American National Standards Institute (ANSI)

1. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, 2009

2. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009

3. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009

4. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, plus errata issued in October, 2008.

5. TIA-569-B (2004; Amd 1 2009) Commercial Building Standard for Telecommunications Pathways and Spaces

D. National Fire Protection Association

1. NFPA 70, National Electrical Code

1.5 SUBMITTALS

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications and the following:

1. As part of the project submittals, the contractor to provide engineered shop drawings indicating the proposed design for mounting all work of this Division as defined under the Seismic Design Requirements and defined elsewhere in this Section, inclusive of mounting systems, equipment mounted at the exterior, inclusive of its effective wind load under the range of conditions expected.

a. Shop drawings to be accompanied by anchorage calculations indicating that it shall remain attached to the mounting surface after experiencing forces in conformance with California Code of Regulations, Title 24, 2007 California Building Code.

b. Structural Calculations shall be prepared and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

1.6 QUALITY ASSURANCE

A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.

B. Cable hooks shall be listed and labeled by Underwriters Laboratories (UL) as required.

C. Cable hooks shall have the manufacturers name and part number stamped in the part itself for identification.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. General

1. Supports to be sized to suit load and selected to match mounting conditions

B. Manufacturers

1. Equal products by the following manufacturers will be considered providing that all features of the specified product are provided:

a. Concrete fasteners:

i. Phillips "Red-Head".

ii. Remington.

iii. Ramset.

iv. Hilti

v. Simpson Strong-Tie

vi. or equal.

b. Concrete inserts and construction channel:

i. Unistrut Corp.

ii. GS Metals "Globe Strut."

iii. Thomas & Betts "Kindorf" Corp.

iv. Or equal.

c. Conduit straps:

i. O-Z/Gedney.

ii. Erico "Caddy" Fastening Products.

iii. Thomas & Betts "Kindorf" Corp.

iv. Or equal.

d. Beam Clamps

i. Cooper B-Line

ii. SuperStrut

iii. Unistrut

iv. or equal

e. Aircraft Cable Sway Braces

i. Mason Industries

ii. M.W. Sausse/Vibrex

iii. Loos & Company, Inc.

iv. or equal.

C. Concrete Fasteners

1. Provide expansion-shield type concrete anchors.

2. Provide powder driven concrete fasteners with washers. Obtain approval by Owner's Representative prior to use.

D. Concrete Inserts

1. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of ¼ inch to ½ inch diameter thread for rod support.

E. Aircraft cable sway braces

1. Steel rope sized to meet load.

F. Construction Channel:

1. Construction:

a. 1-5/8" square galvanized channel formed from U.S.S.G No. 12 or 0.109 inch cold formed steel with 17/32-inch diameter bolt holes, and 1-1/2 inch on center in the base of the channel.

b. 10 foot sections.

2. All supporting materials by same manufacturer.

G. Beam Clamps

1. Malleable iron electro-galvanized steel beam clamps selected to match building structural steel members.

H. Conduit Straps

1. One hole strap, steel or malleable iron, with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.

a. Use malleable strap with spacers for exterior and wet locations.

b. Use steel strap without spacers for interior locations.

2. Steel channel conduit strap for support from construction channel.

3. Steel conduit hanger for pendant support with threaded rod

4. Steel wire conduit support strap for support from independent #12 gauge hanger wires.

I. Threaded rods, couplings, screws and nuts:

1. Electrolytically coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

J. Miscellaneous Parts

1. Hot dipped galvanized after fabrication; after cutting, de-burring and hole drilling. Coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

K. Paint/Tape for Touch-up:

1. Zinc: CRC "Zinc-It", Glyptal, Enterprise Galvanizing “Galambra”, or equal.

2.2 CABLE HANGERS

A. Ceiling Hung J-Hooks

1. Drawing Reference(s):

a. WMJ

b. ACJ

2. Features/Functions/Construction

a. Specifically intended to carry the load of up to 50 communications cables without applying excess forces to cables at bottom of bundle.

b. Integral broad bottom edge to spread cable load with flat bottom and provide a minimum of 1-5/8 inch cable bearing surface.

c. Integral hanger rod attachment hardware at top.

d. Load rated for application.

e. Incorporates smooth 90-degree radiused edges to prevent snagging cable jackets on installation.

f. Designed so the mounting hardware is recessed to prevent cable damage.

g. Integral mechanical cable latch retainer to provide containment of cables within the hook. The retainer shall be removable and reusable.

h. Suitable for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions.

i. Multi-tiered cable hooks to be used where required to provide separate cabling compartments, or where additional capacity is needed.

j. Finishes:

i. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

ii. Cable hooks for corrosive areas shall be stainless steel, AISI Type 304.

3. Manufacturer

a. Cooper B-Line series BCH21, BCH32, BCH64

b. Caddy/Erico CableCat

c. or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The Owner's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the Owner.

3.2 EXAMINATION

A. Thoroughly examine site conditions for acceptance of supporting device installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.3 PREPARATION

A. Coordinate size, shape and location of concrete pads required for equipment installation with the work of the other trades.

B. Lay out support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.

C. Where shown on the Drawings or Specifications, install freestanding communications equipment on concrete pads.

3.4 INSTALLATION

A. Furnish and install supporting devices as noted throughout the Communications Systems work.

B. Communications device and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.

C. Fasten hanger rods, conduit clamps, outlet and junction boxes to building structure using powder actuated tools, precast inserts, expansion anchors, preset inserts or beam clamps.

D. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster or gypsum board partitions and walls.

E. Use expansion anchors or preset inserts in solid masonry walls.

F. Use powder actuated tools, self-drilling anchors, expansion anchor, or preset inserts on concrete surfaces.

G. Use sheet metal screws in sheet metal studs and wood screws in wood construction.

H. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.

I. Do not drill structural steel members unless first approved in writing by the Owner's Representative.

J. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

K. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.

L. Bridge studs top and bottom with channels to support flush mounted cabinets and panelboards in stud walls.

3.5 ERECTION OF METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.6 WOOD SUPPORTS

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.7 DISTRIBUTION PATHWAY VIA CEILING HUNG CABLE HOOKS (J-HOOKS):

A. Void, Plenum or Suspended Ceiling Exposed Cable Installation. Where drawings specifically show or permit use of exposed cable installation in voids, conform to the most restrictive requirements of Code, TIA-569-B and this Section.

B. Provide support for all cabling. Do not place or attach directly to T-bar grid, concealed spline grid, flexible or rigid ductwork, HVAC registers, sprinkler piping or fixtures, light fixtures or building structure. Conform to the California Electric Code.

C. Placement:

1. All pathways created by ceiling hung cable hooks shall be reviewed by the Owner's Representative prior to installation.

2. Ceiling hung cable hooks and cabling supported by same shall not obscure access to access doors, hatches, air dampers, valves, filter sections, VAV boxes, cable trays, junction boxes, pull boxes or similar areas of access required by other trades.

3. All ceiling hung cable hooks shall be mounted close enough together such that upon completion of the station cable installation a minimum amount of cable droop occurs between adjacent rings. The distance between supporting rings shall not exceed 48 inches or as required by the current edition of TIA-569-B.

D. Follow manufacturer's recommendations for allowable fill capacity for each size of cable hook. In no case shall there be more than (50) Fifty UTP Cables supported by one hook.

1. Cable hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

2. Spring steel cable hooks shall be capable of supporting a minimum of 50 pounds with a safety factor of 6 where extra strength is required.

3. No hook shall be loaded to support more than 50 pounds to avoid deforming cables on the bottom of the hook.

4. Where aggregate cable bundle supported by ceiling hung cable hooks exceeds either the rated cable or weight load limit of the ceiling hung cable hook system, provide ceiling basket tray - Type CTW - as specified in Section 27 05 36 – Cable Trays for Communications Systems.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK:

A. Provide telecommunications pathways in accordance with EIA TIA/EIA-569-B, as specified in this Section and as shown on the plans. Provide system furniture pathways in accordance with UL 1286. Provision of all low voltage Communications Systems Pathway and Electronic Security and Safety System Pathway, including:
   1. Rigid steel conduit and fittings.
   2. PVC insulated rigid steel conduit and fittings.
   3. Intermediate metal conduit and fittings.
   4. Electrical metallic tubing and fittings.
   5. Flexible metallic conduit and fittings.
   6. Liquidtight flexible metallic conduit and fittings.
   7. Miscellaneous conduit fittings and products.
   8. Junction Boxes
   9. Floor Boxes
   10. Hinged cover enclosures.
   11. Pullboxes and Terminal Cabinets.

B. At Hazardous Occupancies, installation conforms to the requirements of California Electric Code for Class and Division rating of spaces.

1.2 Related Work in Other Sections:

A. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
   1. Section 01 73 29 – Cutting and Patching.
   2. Section 09 90 00 – Painting and Coating. Exposed conduit and other devices.
   3. Section 27 05 00 – Common Work Results for Communications.
   4. Section 27 05 26 – Grounding and Bonding for Communications Systems
   5. Section 27 05 29 – Hangers and Supports for Communications Systems
   6. Section 27 05 36 – Cable Trays for Communications Systems
   7. Section 27 05 39 – Surface Raceways for Communications Systems
   8. Section 27 05 48 – Noise and Vibration Controls for Communications Systems
   9. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
   10. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
   11. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
   12. Section 27 13 00 – Communications Interior Backbone Cabling
   13. Section 27 14 00 – Communications Outside Plant Backbone Cabling
   14. Section 27 15 00 – Communications Horizontal Cabling
   15. Section 27 41 16 – Integrated Audio-Video Systems and Equipment

1.3 References

A. Usage: In accordance with Section 01 41 00 – Regulatory Requirements.

1. American National Standards Institute (ANSI)
   a. ANSI C80.1 1994 Rigid Steel Conduit - Zinc Coated
   b. ANSI C80.3 1991 Electrical Metallic Tubing - Zinc Coated
2. National Electrical Manufacturers Association (NEMA)
   a. NEMA 250-2003 Enclosures for Electrical Equipment (1000 Volts Maximum)
   b. NEMA FB 1 (ANSI/NEMA FB 1-2003) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
   c. FB 2.10 2000 Selection and Installation Guidelines For Fittings For Use With Non-Flexible Metallic Conduit Or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, And Electrical Metallic Tubing).
   d. FB 2.20 2000 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
   e. NEMA ICS 6 1988 (Rev. 1) Enclosures for Industrial Control and Systems
   f. NEMA OS 3-2002 Selection and Installation Guidelines for Electrical Outlet Boxes.
   g. NEMA RN 1-1998 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   h. NEMA TC 7 2000 Smooth Wall Coilable Polyethylene Electrical Plastic Duct
   i. NEMA TC 13 2000 Electrical Nonmetallic Tubing (ENT).
   j. NEMA TC 14 1984(R 1986) Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
3. Underwriters Laboratories, Inc. (UL)
   a. UL 1 2000 Flexible Metal Conduit
   b. UL 6 2004 Electrical Rigid Metal Conduit - Steel
   c. UL 50 (1995; R 1999, Bul. 2001) Enclosures for Electrical Equipment
   d. UL 360 1986 (Bul. 1991) (R 1993) Liquid-Tight Flexible Steel Conduit
   e. UL 514A 1991 (R 2004) Metallic Outlet Boxes
   f. UL 514B 1989 (R 2004) Conduit, Tubing and Cable Fittings
   g. UL 514C 1996 (R 2000) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
   h. UL 651 1989 (R 1989) (Bul. 1993) Schedule 40 and 80 Rigid PVC Conduit.
   i. UL 797 1993 (R 2004) Electrical Metallic Tubing - Steel
   j. UL 1242 1983 (R1993) (Bul. 1993) Intermediate Metal Conduit.
   k. UL 1286(1999; R 2001, Bul. 2002) Office Furnishings
   l. UL 1479 Fire Tests of Through Penetration Firestops
   m. UL Fire Resistance Directories

1.4 Submittals

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.5 Quality Assurance

A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.
B. Only products and applications listed in this Section may be used on the project unless otherwise submitted and approved by the Owner's Representative.

PART 2 - PRODUCTS

2.1 General

A. Provide the following types of conduit systems listed by their commonly used generic name.

2.2 Raceway

A. Manufacturers:
1. Raceway:
a. Allied Tube and Conduit Co.
b. Triangle PWC, Inc.
c. Western Tube and Conduit Corp.
d. Spring City Electrical Manufacturing Co.
e. Occidental Coating Co. (OCAL).
f. Alflex Corp.
g. American Flexible Metal Conduit Co.
h. Anaconda.
i. Or equal.
2. Fittings:
a. Appleton Electric Co.
b. OZ/Gedney.
c. Thomas & Betts Corp.
d. Spring City Electrical Manufacturing Co.
e. Occidental Coating Co. (OCAL).
f. Carlon.
g. or equal.
B. Rigid Steel Conduit.
1. Drawing and Spec Reference: RSC.
2. Construction:
a. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and UL 6.
b. Standard threaded couplings, locknuts, bushings, and elbows: Only materials of steel or malleable iron are acceptable. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.

c. Three piece couplings: Electroplated, cast malleable iron.
d. Insulating bushings: Threaded polypropylene or thermosetting phenolic rated 150 degree C minimum.
e. Insulated grounding bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
f. Insulated metallic bushings: Threaded cast malleable iron body with plastic insulated throat rated 150 degrees C.
g. All fittings and connectors shall be threaded.

C. Coated Rigid Steel Conduit:
1. Drawing and Spec Reference: CRSC.
2. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
3. Fittings:
a. Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.
b. Fittings over-sleeve to extend 1 conduit diameter or 1-1/2" beyond fitting, whichever is less.
4. Performance:
a. Tensile Strength: 3500 psi.
5. Approvals:
a. NEMA RN1 (Type 40 - 40 mils thick)
b. CalTrans Type 2
6. Manufacturers:
a. Plastibond by RobRoy Industries.
b. Occal-40 by Occidental Coating Company.
c. KorKap by Plastic Applicators.
d. Ocal-Blue
e. or equal.

D. Intermediate Metal Conduit
1. Drawing Reference: IMC
2. Conduit: Hot dip galvanized steel meeting the requirements of CEC Article 345 and conforming to ANSI C80.6 and UL 1242.
3. Fittings: Conduit couplings, connector and bushing shall be as specified for galvanized rigid steel conduit. Integral retractable type IMC couplings are also acceptable.

E. Electrical Metallic Tubing.
1. Drawing and Spec Reference: EMT.
2. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 specifications and shall meet UL classifications.
3. Raintight compression couplings: Electroplate steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
4. Raintight compression connectors: Electroplated steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.

5. Use of set-screw couplings and connectors is not permitted.

F. Flexible Conduit:
1. Drawing Reference: FLEX
2. Construction:
a. Flexible steel, zinc coated on both inside and outside by hot-dipping process.
b. Interlocking spirally wound continuous steel strip.
c. 3/4" minimum size.
3. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Exception: Pressure cast screw-in connectors shall be acceptable for fixture connection in suspended ceilings and cut-in outlet boxes within existing furred walls.
4. Approvals:
a. UL 1

G. Liquidtight Flexible Metallic Conduit
1. Drawing Reference: Liquidtight
2. Conduit: Shall be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquidtight jacket of polyvinyl chloride (PVC) and conforming to UL 360. Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.
3. Fittings: Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push-in ferrule.

2.3 Miscellaneous Conduit Fittings and Products

A. General
1. UL 514B.
2. Listed in UL Electrical Construction Materials List.

B. Conduit Fittings, Insulated Throat Grounding Bushings
1. Description
a. Threaded for Rigid Steel Conduit and Intermediate Metal Conduit.
b. UL Listed for use with copper conductors.
c. Thermoplastic insulated liner for 105 degrees Celsius.
d. Body of malleable iron, zinc plated; or die cast zinc.
2. Manufacturer
a. Thomas & Betts (Steel City) BG-801 Series
b. O-Z/Gedney
c. or equal.

C. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.

D. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.

E. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.

F. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate .75-inch deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless steel jacket clamps. Unit shall comply with UL467 and UL514.
   1. Manufacturer:
      a. OZ/Gedney Type DX
      b. Steel City Type EDF
      c. or equal.

G. Fire rated penetration seals:
   1. UL classified.
   2. Conduit penetrations in fire rated separation shall be sealed with a UL classified assembly consisting of fill, void or cavity materials.
   3. The fire rated sealant material shall be the product best suited for each type of penetration, and may be a caulk, putty, composite sheet or wrap/strip.
   4. Penetrations of rated floors shall be sealed with an assembly having both F and T ratings at least equal to rating of the floor.
   5. Penetrations of rated walls shall be sealed with an assembly having an F rating at least equal to the rating of the wall.

H. Standard products not herein specified:
   1. Submit for review a listing of standard electrical conduit hardware and fittings not herein specified prior to use or installation, i.e. locknuts, bushings, etc.
   2. Listing shall include manufacturers name, part numbers, and a written description of the item indicating type of material and construction.
   3. Miscellaneous components shall be equal in quality, material, and construction to similar items herein specified.

I. Hazardous area fittings: UL listed for the application.

2.4 Junction and Device Boxes

A. Junction and Device Boxes
   1. Drawing References: As shown on Symbol Schedule
   2. Construction:
      a. Concealed/Flush Mounted:
      b. One or two piece welded knockout boxes.
      c. UL 514A, cadmium or zinc-coated 1.25 oz/sq. ft., if ferrous metal.
      d. Pressed sheet steel, for indoor locations.
      e. UL 514C approved if non-metallic.
      f. At hollow masonry, tile walls and plaster walls, provide with device rings as required.
      g. Surface mounted:

i. Exterior - Conform to the Junction and/or PullBox construction scheduled on the Plans. Where construction not otherwise scheduled or noted on the plans, conform to the following.:
(1) Cast iron or aluminum with threaded hubs and mounting lugs.
(2) Gasketed cover with spring lid.
ii. Concrete floor embedded:
(1) Cast iron concrete pour boxes with screwed brass cover, unless otherwise noted.
(2) Cadmium plated screw cover attachment at least 6" on center.
h. If size not otherwise noted, at least 4S (4" square) by 2-1/8" deep, or Code minimum size, whichever is larger.
i. Wherever 4S is indicated, contractor may at their option substitute 4-11/16" square boxes while maintaining the minimum depth required by these specifications and the drawings.
ii. At recessed masonry wall installations, provide gangable masonry boxes.
i. Provide complete with approved type of connectors and required accessories, including attachment lugs or hangers. Provide raised device covers as required to accept scheduled device.
3. Approvals.
a. UL 514A
4. Manufacturers:
a. Interior:
i. Steel City.
ii. Bowers
iii. Randl Industries, Inc. (5S Boxes).
iv. or equal.
b. Interior, 5S Boxes
i. Randl, Inc. 5 Square Telecommunications Boxes
ii. or equal.
c. Exterior, exposed with cover of same construction.
i. Appleton
ii. Pyle-National
iii. or equal.
d. Other conditions:
i. Any meeting approvals and requirements.
B. Flat-panel Wall Box
1. Drawing reference: FPWB
2. Features, functions and construction:
a. Box provides means to install audiovisual, network and power receptacles flush in wall behind flat-panel display. With box cover installed, connectors are concealed and cables, both power and communications pass through slot at base of cover plate into connection points on back of flat-panel.
b. Cover plate protrudes less than 1/2" from face of wall.
c. 16 gauge box construction with 1/16" inch thick minimum cover

plate, white finish baked enamel or powder coat, field paintable

d. Box incorporates provisions to mount up to two electrical device boxes for provision of duplex power receptacles either from above or below.

e. Additionally box mounts manufacturers low-voltage conduit entry box which accommodates manufacturer's line of audiovisual connector inserts. Design of FP WB permits installation of up to two low-voltage conduit entry boxes, which may be mounted either above or below the FPWB.

f. Manufacturers audiovisual insert line shall support at least the following receptacles:

i. BNC, in combinations of 1 to 5 BNC's, color-coded for composite, component analog and RGBHV video formats, as required.

ii. RCA, in combinations of 1 to 3 RCA's color-coded for composite and component analog video formats, as required.

iii. XLR, 3 and 4 pin.

iv. DB-15

v. DB-9

vi. Neutrik Speakon.

vii. DVI

viii. HDMI

ix. 1/4" and mini TRS.

g. Fill unused openings with blank inserts.

3. Manufacturers:

a. FSR Inc.

i. PWB-100, with connectors and inserts from manufacturer's IPS series as required to provide the interfaces and connectivity indicated on the plans.

ii. PWB-250, with connectors and inserts from manufacturer's IPS series Is required to provide the interfaces and connectivity indicated on the plans.

b. Wiremold ESW

c. Or equal.

2.5 Cabinets and Enclosures

A. Terminal Cabinets:

1. Drawing Reference: As Scheduled.

2. Construction:

a. Zinc Coated Sheet Steel, code gauge with standard concentric knockouts for conduit terminations.

b. Interior dimensions not less than those scheduled.

c. Finish: Manufacturer's standard gray baked enamel finish.

d. Covers: Trim fitted, continuous hinged steel door, flush catch – lockable and keyed to match. Screw fastened doors not acceptable.

i. Door face to be not less than 95% of panel interior dimensions.

e. Provide with 3/4" fire retardant treated ply backboard.

3. Mounting:

a. Flush cabinets shall be furnished with concealed trim clamps and shall be not less than 4 inches deep.

b. Surface cabinets shall be furnished with screw cover trim, flush hinged door and shall not be less than 6 inches deep.

c. Interior Applications:

i. NEMA 250 Type 1, unless otherwise noted. Refer to plans and schedules.

d. Exterior Applications:

i. NEMA 250 Type - As Scheduled, not less than NEMA 3R.

4. Manufacturers:

a. B-Line Electrical Enclosures

b. Circle AW Products.

c. Hammond

d. Henessey.

e. Hoffman.

f. Myers Electric Products

g. Rittal.

h. or equal.

2.6 Floor Boxes, Poke-Throughs and Monuments

A. Floor Box, Cast Iron, Recessed Devices, with Lid Designed to meet UL Scrub Water Listing

1. Drawing Reference: FC3

2. Construction

a. At grade conditions, Cast Iron, suitable for grade installation without special means of protection. Elsewhere, cast iron or stamped steel.

b. Four 1-Gang openings divisible between power and low voltage applications fully recessed below the floor level

c. Slotted and gasketed activation cover provides protection for both communications and electrical receptacles at box interior. Activation cover has removable recesses to permit installation of pieces of surrounding flooring finish to be integrated in lid to minimize visual appearance of lid. Activation covers shall be manufactured of die-cast aluminum or die-cast zinc, and be available in a plated brass finish. Activation covers shall be available in flanged and flangeless versions - select to match surrounding floor covering. Covers shall be available with options for tile or carpet inserts, flush covers, or covers with one 1" trade size screw plug opening and one combination 1 1/4" and 2" trade size screw plug openings for furniture feed applications. Covers, when open, provides at least 35 square inches of clear opening to access receptacles at box interior.

d. Cables can be routed internally between two adjacent 1 gang openings to permit a single conduit to serve both.

e. UL Listed for power service.
f. Lid rated for 900 pound load without damage.

3. Approvals:
   a. UL 514C scrub water
4. Manufacturers
   a. Wiremold RFB4-4DB above grade and RFB4-CI-1 at grade conditions. Provide FloorPort Flanged Cover Assemblies to match floor conditions, Owner's Representatives finish selection, and exit raceway, where indicated. Provide internal device brackets to match specified communications devices and plates. Coordinate electrical rough-in with requirements of Division 26. Provide rough-in as required to mount specified communications fill.
   b. Thomas & Betts
   c. Hubbell
   d. or equal

B. Floor Box High Capacity, 3 Compartment
1. Plan Reference: FC4, FW4, FR4
2. Features
   a. UL Listed
   b. Box
      i. Size at least 10 inches by 12 inches by 6 inches deep.
      ii. Three compartments, with voltage barriers, with standard electrical plate mounting brackets for at least:
         (1) One single gang
         (2) One 2 gang
         (3) One 4 gang
   c. Knockouts concentric, combination 1 inch and 1.25 inch.
   d. Select cover for to match floor finish as scheduled in Architectural/Interiors plans and specifications.
      i. At floor surfaces scheduled in the Architectural/Interiors plans and specifications to receive carpet, provide with carpet flange and coordinate carpet cut and insertion.
      ii. At floor surfaces scheduled in the Architectural/Interiors plans and specifications to be installed as smooth finishes, including exposed concrete, provide smooth cover and omit carpet flange.
      iii. At Core Seawater Lab, provide solid aluminum lid w/ no carpet flange.
   e. Cover size approximately 10.5 inches by 12.5 inches.
   f. At least 11 gage steel.
   g. Carpet flange of mitered brass or aluminum edging.
      i. Option of brass or aluminum to be selected by the University's Representative.
      ii. Option of 0.25 inch or 0.5 inch flange height to be selected by the University's Representative.
      iii. Option for solid aluminum cover with no carpet flange.
   h. Within cover, provide a lift-off, full-access door, open area approximately 6.5 inches by 8 inches.

i. Within the lift-off, full-access door, provide a hinged, fold-back cable exit port.
j. Open area of cable pass-through approximately 2 inches by 2 inches.
k. Flush in closed position.

3.

4. Applications:
   a. FC4: Concrete floor systems. Provide "pour pan" protection or manufacturer's equivalent protection system at slab on grade conditions. At upper floor conditions, provide UL listed 3 hour rated assembly per UL 263.
   b. FR4: Raised Floor Conditions.
   c. FW4: Wooden Floor Conditions.
5. Approvals:
   a. UL 514A scrub water
   b. UL 263 at applications above grade level.
6. Manufacturers
   a. FSR Inc.
      i. FC4: FL-500P-(cover flange code)-6. Supply larger boxes where scheduled and indicated plates and jacks require it.
         (1) Provide manufacturer's "Pour Pan" FL-GRD2 or FL-GRD4 to protect from moisture at installations at grade level.
         (2) At floor levels above grade, provide FL-500P-6-FRK system with required cover.
      ii. FW4, FR4: FL-540P-(cover flange code)-4. Supply larger boxes where scheduled and indicated plates and jacks require it.
   b. RCI Systems, Inc.
      i. FC4: FB-2600. Supply larger boxes where scheduled and indicated plates and jacks require it.
         (1) Provide manufacturer's "Pour Pan" to protect from moisture at installations at grade level.
   c. Wiremold Evolution Floor Box, EFB8S, EFBS-OG where installed at grade, EFB8S-FC, at upper floor/ceiling assemblies with a 2–hour or less fire rating.
   d. Or equal.

C. Floor Box High Capacity, 4 Compartment
1. Plan Reference: FC6, FW6, FR6
2. Features
   a. UL Listed
   b. Box
      i. Size at least 13.5 inches by 12 inches by 6 inches deep.
      ii. Four compartments, with voltage barriers, with standard electrical plate mounting brackets for at least:
         (1) One 6 gang
         (2) One 3 gang
         (3) Two single gang
   c. Knockouts concentric, combination 1 inch and 1.25 inch.

d. Select cover for to match floor finish as scheduled in Architectural/Interiors plans and specifications.
   i. At floor surfaces scheduled in the Architectural/Interiors plans and specifications to receive carpet, provide with carpet flange and coordinate carpet cut and insertion.
   ii. At floor surfaces scheduled in the Architectural/Interiors plans and specifications to be installed as smooth finishes, including exposed concrete, provide smooth cover and omit carpet flange.
   iii. At Core Seawater Lab, provide solid aluminum lid w/ no carpet flange.
   iv. carpet finish.
e. Cover size approximately 14 inches by 12.5 inches.
f. At least 11 gage steel.
g. Carpet flange of mitered brass or aluminum edging.
   i. Option of brass or aluminum to be selected by the University's Representative.
   ii. Option of 0.25 inch or 0.5 inch flange height to be selected by the University's Representative.
h. Within cover, provide a lift-off, full-access door, open area approximately 6.5 inches by 8 inches.
i. Within the lift-off, full-access door, provide a hinged, fold-back cable exit port.
j. Open area of cable pass-through approximately 2 inches by 2 inches.
k. Flush in closed position.

3. Applications:
   a. FC6: Concrete floor systems. Provide "pour pan" protection or manufacturer's equivalent protection system at slab on grade conditions. At upper floor conditions, provide UL listed 3 hour rated assembly per UL 263.
   b. FR6: Raised Floor Conditions.
   c. FW6: Wooden Floor Conditions.
4. Approvals:
   a. UL 514A scrub water
   b. UL 263 at applications above grade level.
5. Manufacturers
   a. FSR Inc.
      i. FC6: FL-600P-(cover flange code)-6. Supply larger boxes where scheduled and indicated plates and jacks require it.
         (1) Provide manufacturer's "Pour Pan" FL-GRD2 or FL-GRD4 to protect from moisture at installations at grade level.
         (2) At floor levels above grade, provide FL-605P-6-FRK system with required cover.
      ii. FW6, FR6: FL-640P-(cover flange code)-6. Supply larger boxes where scheduled and indicated plates and jacks require it.
   b. RCI Systems, Inc.
   c. Wiremold/Walker

d. or equal.

D. Floor Box, Electrified Furniture Feed

1. Plan Reference: EFM, FF4
2. Minimum Box Features/Function/Construction:
   a. Stamped steel or cast construction
      i. If stamped steel, provide painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete,
   b. Approved for use on grade and above grade floors.
   c. The box shall have nominal dimensions of 13 1/8" L x 12 1/2" W x 3 1/4" H
   d. Six independent wiring compartments that allow capacity for up to six duplex receptacles and/or communication services.
   e. Construction permits feed through tunneling from adjacent compartments.
   f. Two of the six compartments shall have a minimum wiring capacity of 23 cu in.
   g. Four compartments shall have a minimum wiring capacity of 52cu in.
   h. The box have at least the following number of trade standard conduit knockouts:
      i. Twelve ¾".
      ii. Four 1",
      iii. Twelve 1 1/4".
   i. The box shall be fully adjustable, providing at least 1 3/8" of pre-pour adjustment, and at least 3/4" of after-pour adjustment.
   j. The box shall provide a series of device mounting plates that will accept both duplex power devices, as well as plates that will accommodate Owner standard workstation connectivity outlets and modular inserts, and other open system devices.
3. Minimum Cover/Lid Features/Function/Construction:
   a. Flanged cover for use in tile or carpet installation.
   b. Die-cast aluminum assembly available in black, bronze, brass, nickel, gray, or brushed aluminum for color selection by the Owner's Representative.
   c. Provided with one 1" trade size screw plug for power or communication type cabling and one combination 1 1/4" and 2" trade size screw plug for communication type cabling.
   d. Allows for feeding both power and communication cabling.
4. Approvals:
   a. UL
   b. The activation cover shall have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
5. Manufacturers:
   a. Wiremold RFB6-OG with FloorPort Series Cover FPFFTC**, where ** reflects the color option selected by the Owner.
   b. Hubbell
   c. FSR
   d. or equal.

PART 3 - EXECUTION

3.1 Conduit Application

A. General: Install the following types of conduits and fittings in the locations listed, unless otherwise noted in the drawings:
   1. Exterior, Exposed:
      a. Type RSC for applications up to 8 feet AFF or to first pull box, whichever is first, applications subject to physical abuse or for applications greater than 4" diameter.
      b. EMT acceptable in all other applications not noted above up to 4", where used in conjunction with specified Raintight (compression) couplers.
   2. Interior, Exposed, Wet and Damp Locations:
      a. Type RSC.
      b. At interior locations over 8 feet above finished floor, EMT acceptable.
   3. Interior, Hazardous Locations
      a. Type RSC
      b. Type IMC, where permitted by the CEC.
   4. Interior, exposed or concealed, dry locations:
      a. RSC, if subject to physical abuse.
      b. EMT, if not subject to physical abuse.
   5. Interior, concealed, damp locations, including in masonry walls.
      a. RSC
   6. Embedded in Concrete
      a. RSC or rigid non-metallic conduit.
      b. PVC Type Schedule 40.
   7. Transition from walls, floor boxes and monuments to open plan furniture systems:
      a. Liquidtight

3.2 General Requirements

A. Refer to the manufacturer's instructions and conform thereto.
B. Distribution Pathway via EMT Raceway:
   1. EMT conduit is to be installed meeting the NEC handbook Article 348 Installation Specifications.
   2. Provide escutcheon plates for all through wall conduit stubs.
   3. All ends of conduits shall be cut square, reamed and fitted with insulated bushing.
   4. All conduit which passes through fire walls shall be sealed with fire stop putty after all station wire has been installed.

3.3 Mounting and Installation – Device Boxes

A. Conform to the more restrictive of NEMA OS 3-2002 and the following.

B. Provide backboxes at all communications systems devices. Installation of device plates directly to wall surface without use of a backbox, unless specifically directed on plans, is unacceptable.
C. The distance between pull boxes shall not exceed 150 feet or more than two 90 degree bends.
D. Align boxes plumb with floor and surrounding construction. At door frames, locate 4" from frame. Verify placement with Owner's Representative details to ensure that box clears all trim, etc.
E. Support and fasten boxes securely. At stud walls use rigid bar hangers, attached to hanger with stud and nut.
F. At existing locations, provide cutting, patching and finishing as required to maintain or restore finishes so that resulting installation is integrated into the Architectural decor of the particular location.
G. Mounting Height: the mounting height of a wall-mounted outlet box is defined as the height from the finished floor to the horizontal center line of the cover plate.
H. Mount outlet boxes with the long axis vertical. Three or more gang boxes shall be mounted with the long axis horizontal.
I. Install wiring jacks and outlet devices only in boxes which are clean; free from excess building materials, dirt, and debris.
J. Install wiring jacks and outlet devices after wiring work is complete.

3.4 Terminal Cabinets, Junction Boxes and Pull Boxes

A. General
1. Thoroughly examine site conditions for acceptance of cabinets and enclosures installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.
B. Set cabinets and enclosures plumb and symmetrical with building lines. Furnish and install all construction channel bolts, angles, etc. required to mount all equipment furnished under this Section of the Specifications.
C. Cabinets and enclosures shall be anchored and braced to withstand seismic forces calculated in accordance with standards referenced in Section 27 05 29 – Hangers and Supports for Communications Systems.
D. "Train" interior wiring, bundle and clamp using specified plastic wire wraps. Separate power and signal wiring.
E. Replace doors or trim exhibiting dents, bends, warps or poor fit that may impede ready access, security or integrity.
F. Terminate conduit in cabinet with lock nut and grounding bushing.
G. Cleaning
1. Touch-up paint any marks, blemishes or other finish damage suffered during installation.
2. Vacuum clean cabinet on completion of installation.

3.5 Support

A. Provide supports for raceways as specified in Section 27 05 29 – Hangers and Supports for Communications Systems.

B. All raceways installed in exposed dry locations shall be grouped in a like arrangement and supported by means of conduit straps, wall brackets or trapeze hangers in accordance with Code and the requirements of this Section and Section 27 05 29 – Hangers and Supports for Communications Systems. Fasten all hangers from the building structural system.

C. Provide supports and mounting attachments per the most restrictive of Code and the following.

Raceway Size (inches)	No of cables in run	Location	Support Spacing (feet)	
			RSC	EMT
Horizontal Runs				
½, 3/4	1-2	Flat Ceiling Wall Runs	5	5
½, 3/4	1-2	Where access limited to building structure	7	7
½, 3/4	3≥	Any location	7	7
1≥	1-2	Flat ceiling or wall	6	6
1≥	1-2	Where access limited to building structure	10	10
1≥	3≥	Any locations	10	10
Any	Any	Concealed	10	10
Vertical Runs				
½, 3/4	Any	Exposed	7	7
1, 1-1/4	Any	Exposed	8	8
1-1/2≥	Any	Exposed	10	10

D. Install no more than one coupling or device between supports.

E. Conduit support
   1. As specified in Section 27 05 29 – Hangers and Supports for Communications Systems

F. The Owner's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the Owner.

3.6 Penetrations

A. Gypsum Wall Board Penetrations: Provide circular penetrations maximum 1/8" inch larger than outer diameter of conduit being used. On both sides of the wall fill space between conduit and wall with joint compound, depth to match gypsum board thickness.

B. Install UL listed fire-stop system whenever a raceway penetrates a firewall in conformance with the manufacturer's directions, the published systems assembly requirements, CBC Section 709 and 710 and CEC 300-21, whichever is the most restrictive. At cable tray penetrations, provide pillow type removable fire stop per CBC Section 709 and 710, the published systems assembly requirements and the manufacturer's directions, whichever is the most restrictive.

C. All communications systems conduit openings in walls and floors are the responsibility of the Contractor. Install sleeves shown on the drawings when the concrete is poured. Any openings required after the concrete has set maybe core drilled.

3.7 Raceway Installation

A. General

1. Raceway runs are shown schematically. Install concealed unless specifically shown otherwise. Supports, pull boxes, junction boxes and similar generally not indicated. Provide where designated.
   a. Install exposed conduit and raceway parallel and perpendicular to nearby surfaces or exposed structural members, and follow the surface contours. Level and square conduit and raceway runs.
   b. Raceway runs shall be mechanically and electrically continuous between all each equipment rack and utility demarcation point, receptacle and/or surface raceway strip, as applies.
   c. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box, or outlet by means of a locknut on the outside and a bushing on the inside or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter.
   d. Bends
      i. All bends or elbows shall have a minimum radius as follows:

Conduit Size	Min. Radius (Inches)
3/4"	8
1"	12
1-1/4"	18
2"	24
2-1/2"	24
3"	30
3-1/2"	30
4"	30
5"	36
6"	42

         (1) Use factory elbows or machine bends for conduit bends 1-1/4" and larger.
   e. Make bends and offsets so the inside diameter is not effectively reduced. Make bends in parallel or banked runs from the same center line so that the bends are parallel.
   f. Install at least one (1) 3/8", 200 pound strength nylon pull cord in all empty raceways.
   g. Raceways crossing building expansion joints or in straight runs exceeding 100 feet shall be provided with UL listed expansion fittings.
   h. Install conduit seals and drains to prevent accumulated moisture in conduits from entering Communications System enclosures.

2. Do not install conduit in concrete slabs unless specifically directed by Owner's Representative. Embedded conduits in concrete slab walls, and columns shall be installed in center third between upper and lower layers of reinforcing steel as directed by the Owner's Representative. Space conduits 8" on center except at cabinet locations where slab thickness shall be increased as directed by the Owner's Representative.
3. All conduits to be kept 12" away from steam or hot water lines. Install horizontal conduit and raceway runs below water and steam piping.
4. Conduit dropping down to equipment shall be as straight as possible without any offsets, parallel or perpendicular to walls, ceilings and other building features.
5. Conduit installed on any equipment shall be run symmetrical with the equipment and in such a manner as to:
   a. not to be exposed to damage;
   b. not interfere with access to components of the equipment that will interfere with maintenance operation or;
   c. not to be in a manner that the Owner deems detrimental to its operation.
6. Whenever an installation such as that listed occurs, the Contractor shall make all necessary changes at no additional cost to the Owner.
7. All cut ends of conduit, scratches, tool marks, etc. on any metallic raceway installed in the ground or on the exterior of the building shall be treated with two coats of specified Touch Up Paint/Tape.
8. Exposed conduit and metallic surface raceway installed in finished spaces shall be painted to match surrounding surfaces using paint and methods directed by the Owner's Representative.
9. All raceways stubbing up into equipment or racks shall be sealed. Raceways with conductors shall be plugged with duct-seal. Spare raceways shall be capped. Prevent foreign matter from entering conduit and raceway; use temporary closure protection. Replace conduits containing concrete, varnish or other foreign material.
10. Complete installation of conduit and raceway runs before starting installation of cables/wires within conduit and raceway.
11. Use specified conduit and raceway fittings that are of types compatible with the associated conduit and raceway and suitable for the use and location. Join and terminate conduit and raceway with fittings designed and approved for the purpose of the conduit and raceway system and make up tight.
12. Where chase nipples are used, align the raceway and coupling square to the box and tighten the chase nipple so no threads are exposed.
13. Horizontal conduit or EMT runs, where required and permitted, shall be installed as close to ceiling or ceiling beams as practical.
14. Conduit and EMT connected to wall outlets shall be run in such a manner that they will not cross water, steam or waste pipes or radiator branches.
15. Conduit and EMT shall not be run through beams, purlins or columns except where permission is granted by Owner's Representative in writing.
16. Bond installed metallic raceway in accordance with the requirements of the CEC.

3.8 Hazardous Locations

A. Use rigid steel conduit only.
B. Install UL listed sealing fittings that prevent passage of explosive vapors in accordance with the manufacturers written instructions. Locate fittings at suitable, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank coverplate having a finish similar to that of adjacent plates or surfaces.
C. Install raceway sealing fittings at the following points and elsewhere as indicated:
   1. Where conduits enter or leave hazardous locations.

3.9 Reuse of Existing Conduit

A. General
   1. Existing conduit is to be used as a pathway only where so shown on the drawings.
   2. Prior to beginning work involving the use of an existing conduit, the Contractor shall consult with the Owner's Representative in order to establish whether or not the conduit contains active service.
   3. If no active service exists within the conduit, all cable is to be removed, and work is to proceed.
   4. If active service does exist within the conduit and it has been determined that service needs to be disrupted, then work on that conduit shall not proceed until a schedule of service outage has been established by Owner's Representative. Once given direction to proceed, the Contractor shall within the time period of one (1) working day; remove the old cable, install, terminate and test the new cables, and notify the Owner's Representative the work using the specific conduit has been completed. The Owner's Representative shall be responsible for the disconnection and reconnecting of the active service cross-connects within the terminal closet(s).
B. Conduit preparation procedure:
   1. Remove existing wires and cables (if any).
   2. Run a mandrel ½" smaller than the inside diameter of the conduit through the conduit receiving new wires and cables.
   3. If the specified size mandrel will not pass through the existing conduit, start with a smaller size mandrel and increase mandrel size until the specified sized mandrel will pass.
   4. Run a wire brush and clean rag with an outside diameter 1/8" larger than the inside of the conduit through the conduit receiving new wires and cables.
   5. Repeat above until conduit is clean and materials detrimental to the wire and cables to be installed no longer exit conduit with the clean rag.

3.10 Station Cable Pathway Installation

A. Work Area Outlet Boxes:
   1. Unless otherwise noted on the plans, all cut in boxes and surface station outlet boxes are to be installed at a height of 18" A.F.F.(above finished floor) to center, except for those intended to be used for telephone wall

jacks. Those plates or boxes that are to be used for wall mounted (630A plate style) telephone instruments shall be installed at a height of 48" A.F.F to center per CBC/California Access Compliance standard.

2. All station outlets shall be installed so that their edges are parallel to the vertical and horizontal edges of the surface on which they are mounted.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Cable Trays for Communications Cabling
   1. Cable Trays
   2. Cable Runways
   3. Basket Tray

B. Cable Tray Support

1.2 Related Work Under Other Sections

A. Related Sections:
   1. Section 27 05 00 – Common Work Results for Communications
   2. Section 27 05 26 – Grounding and Bonding for Communications Systems
   3. Section 27 05 29 – Hangers and Supports for Communications Systems
   4. Section 27 05 33 – Conduits and Backboxes for Communications Systems
   5. Section 27 05 39 – Surface Raceways for Communications Systems
   6. Section 27 05 48 – Noise and Vibration Control for Communications Systems
   7. Section 27 05 53 – Identification for Communications Systems

1.3 References

A. Usage: In accordance with Section 01 41 00 – Regulatory Requirements.
   1. National Electrical Manufacturers Association (NEMA)
      a. NEMA FG 1 1-1998 Fiberglass Cable Tray Systems
      b. NEMA VE 1 1-1998 Metal Cable Tray Systems.
      c. NEMA VE 2 2001 Metal Cable Tray Installation Guidelines

1.4 Submittals

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.5 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

1.6 Sequencing

A. Not Used.

PART 2 - PRODUCTS

2.1 Cable Tray, Cable Runway and Basket Tray

A. Cable Tray
1. Drawing and spec reference: CTxx-yy, where "xx" denotes nominal width of cable runway in inches and “yy” denotes nominal depth.
2. Construction:
a. Steel or aluminum.
b. Rungs 9" on center, unless otherwise noted.
c. UL Classified splice kits.
d. Accessories. Provide with a complete system of accessories, including radiused corners at vertical and horizontal bends, section splice plates, expansion plates, blind-end plates, etc. Provide waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
3. Approvals:
a. ASTM A513
b. California Electrical Code, Article 318
c. NEMA VE1 Class 12C minimum, or to suit indicated cable and raceway loads, whichever is greater.
4. Manufacturers:
a. B-Line Cable Tray Systems Ladder Type Cable Tray with a complete system of accessories, including Ladder Drop-outs
b. Globe Tray
c. PW Industries
d. or equal.

B. Cable Runway
1. Drawing and spec reference: CR*, where "*" denotes nominal width of cable runway in inches.
2. Construction:
a. Solid Steel Side Bar per ASTM A-36 or Tubular Steel Side Bar per ASTM A-513.
b. 1.5" x 0.375 minimum tubular side stringers.
c. UL Classified splice kits.
d. Designed to support at least 100 pounds per foot load with a Safe Working Load deflection of ½” or less.
3. Finish: Telco gray powder coat or gold on zinc plating.
4. Approvals:
a. ASTM A513
b. UL Classified as an equipment grounding conductor.
c. California Electrical Code, Article 318
5. Manufacturers:
a. B-Line Telecom-Saunders SB-17.
b. Chatsworth Products Inc. 11275 series.
c. PW Industries
d. or equal.

C. Cable Tray, Open Wire Frame
1. Drawing and spec reference(s): CTWxx-y, where xx denotes the tray

width and y the depth of the tray, in inches.

2. Construction
   a. Welded wire mesh with continuous safety edge wire lip.
   b. Mesh forms grid at nominally 2" by 4"
   c. Carbon Steel
   d. Electroplated zinc galvanized
   e. All bends, seams and joints field fabricated from basic straight section pieces and splice components as supplied by the manufacturer.
   f. Provide a complete system of accessories, including bonding and grounding connections, conduit connectors, to terminate conduits extended to basket edge, radius shields to protect cabling at inside corners, and waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
   g. Where supported from ceiling, supported at both sides in trapeze arrangement – centerline support not acceptable.
   h. Provides pathway complying with EIA/TIA-569B and NEMA Publications VE1 & VE2
   i. Meets requirements of California Electrical Code, Article 318
3. Approvals:
   a. NEMA Publications VE1 & VE2
4. Manufacturers:
   a. B-Line Wire Basket Runway with B-Line Conduit Connectors, Radius Shields, and Drop-out sized to match the indicated raceway, either individually or in combinations of multiple units.
   b. Cablofil
   c. G.S. Metals Corp
   d. PW Industries
   e. or equal.

PART 3 - EXECUTION

3.1 Cable Tray Application

A. Unless otherwise noted, communications cable tray installations shall conform to the following:
   1. Type CT - Within Communications Rooms (including Telecomm Building (ADF), BDF and IDF spaces)
   2. Type CTW - Horizontal station cabling outside of the communications rooms where shown on plans or where more than 100 cables are supported, whichever is greater.
   3. Type CR – Wherever vertical transitions from ceiling or floor sleeves are required within the Communications Room.

3.2 Installation:

A. Provide all required supports, fittings and accessories for a complete system as described in NEMA VE-2, by Code, manufacturer recommendation or as shown on the plans, whichever is most restrictive.

1. Cable Tray. Provide with a complete system of accessories, including UL Classified splice kits, radiused corners at vertical and horizontal bends, section splice plates, expansion plates, blind-end plates, etc. Provide waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.
2. For wire basket tray, provide a complete system of accessories, including bonding and grounding connections, conduit connectors, to terminate conduits extended to basket edge, radius shields to protect cabling at inside corners, and waterfall drop-outs at each end of cabling racks and cabinets indicated on the plans scheduled or indicated to terminate open wiring systems.

B. Bond sections to one another and to building ground. Provide external grounding strap at expansion joints, sleeves, crossovers and at other locations where tray continuity is interrupted.

C. Access Clearance. Maintain access for use by Owner's personnel to tray as described below. Coordinate installation with work of structural, mechanical, plumbing/fire protection and electrical trades to maintain required access.
1. Unless shown otherwise on the plans, provide a clear access of at least 24" wide along one side of each tray for use by Owner's personnel.
2. Unless shown otherwise on the plans, installation to maintain at least 12" vertical clearance over the top of each tray for use by Owner's personnel.
3. A minimum of 3” of clearance from the top of the finished ceiling to the bottom of the cable tray shall be provided.

D. Provide conduit to tray fitting at each conduit entrance to tray or maximum 8” of vertical drop to cable tray.

3.3 Support

A. Support in accordance with the most restrictive of the following:
1. Contractor’s engineered means of engineered support submitted in accordance with the requirements of 27 05 00 – Common Work Results for Communications and Section 27 05 29 – Hangers and Supports for Communications Systems.
2. California Building Code.
3. Metallic Cable Tray: NEMA VE 2-2001, or latest edition
4. Fiberglass Cable Tray: NEMA FG-1-1998, or latest edition.

B. Provide a safety-loading factory of 1.5 for uniformly distributed loads when supported as a simple span in accordance with the NEMA standard listed.

C. Size support member within load rating of member section; and without visible deflection. Install cable tray level and straight.

D. Provide lateral sway bracing as required by Code.

3.4 Penetrations

A. Install firestop wall frames around cable tray at penetrations through fire rated walls, and where called for. Seal these openings with pliable fire resistant sealant.

B. Cable Trays shall not penetrate any firewall or fire-rated soffits without the means to maintain existent wall fire rating. At such conditions, provide a listed through penetration system with equivalent cross sectional area to the tray being interrupted.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, and set up of the Communications System Raceway, Conduit and Backbone work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, contiguous working raceway systems.

B. Communications Outside Plant Ductwork - refer to the drawings for demarcation of the work of this Project.
   1. Communications Outside Plant Ductwork.
   2. Communications Manholes
   3. Communications Pullboxes

1.2 Related Work:

A. Related Work in Other Sections:
   1. Section 03 30 00 – Cast-In-Place-Concrete
   2. Section 27 05 00 – Common Work Results for Communications.
   3. Section 27 05 26 – Grounding and Bonding for Communications Systems
   4. Section 27 05 33 – Communications, Raceways, Boxes and Fittings
   5. Section 27 05 53 – Identification for Communications Systems
   6. Section 27 11 23 – Communications Cable Management
   7. Section 31 23 33 - Trenching and Backfilling

1.3 Regulatory Requirements

A. In addition to requirements of Section 01 41 00 – Regulatory Requirements, comply with the following.
   1. Public Utilities Commission of the State of California.
      a. Rules for Overhead Electric line Construction, General Order No. 95 inclusive of all Decisions or Resolutions thereto authorized with Date Effective up to and including 30 days prior to the bid opening day.
      b. Rules for Underground Electric Line Construction, General Order No. 128 inclusive of all Decisions or Resolutions thereto authorized with Date Effective up to and including 30 days prior to the bid opening day.

1.4 References

A. Usage: In accordance with Section 01 41 00 – Regulatory Requirements.

B. BICSI
   1. 2004 Customer Owned Outside Plant Design Manual

C. American National Standards Institute (ANSI)
   1. ANSI C80.1 1990 Rigid Steel Conduit - Zinc Coated

D. State of California, Business, Transportation and Housing Agency, Department of Transportation (CalTrans)

1. Standard Specifications, July, 1999, or latest edition.
2. Standard Plans, July 1999 or latest edition.

E. National Electrical Manufacturers Association (NEMA)

a. NEMA 250-2003 Enclosures for Electrical Equipment (1000 Volts Maximum)
b. ANSI/NEMA FB 1-2003 Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
c. FB 2.10 2000 Selection and Installation Guidelines For Fittings For Use With Non-Flexible Metallic Conduit Or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, And Electrical Metallic Tubing).
d. FB 2.20 2000 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
e. NEMA FG 1 1-1998 Fiberglass Cable Tray Systems
f. NEMA ICS 6 2001 Industrial Controls and Systems Enclosures
g. NEMA RN 1 1998 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
h. NEMA TC 2 2003 Electrical Polyvinyl Chloride (PVC) Conduit
i. NEMA TC 3 1999 PVC Fittings for Use with Rigid PVC Conduit and Tubing
j. NEMA TC 6&8 2003 PVC Plastic Utilities Duct for Underground Installations
k. NEMA TC 7 2000 Smooth Wall Coilable Polyethylene Electrical Plastic Duct
l. NEMA TC 9 1999 Fittings for ABS and PVC Plastic Utilities Duct for Underground Application
m. NEMA TC 14 1984(R 1997) Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings
n. NEMA TC 19 2001 Nonmetallic Riser U-Type Guards
o. NEMA VE 1 1-1998 Metallic Cable Tray Systems.
p. NEMA VE 2 2001 Cable Tray Installation Guidelines

2. Underwriters Laboratories, Inc. (UL)

a. UL 6 2004 Electrical Rigid Metal Conduit - Steel
b. UL 360 1986 (R 2003) Liquid-Tight Flexible Steel Conduit
c. UL 514A 1991 (R 2004) Metallic Outlet Boxes
d. UL 514B 1989 (R 2004) Conduit, Tubing, and Cable Fittings
e. UL 514C 1988 (R 1996) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
f. UL 651 1989 (R 1995) Schedule 40 and 80 Rigid PVC Conduit.

1.5 Submittals

A. Conform with the requirements of Division 1 and Section 27 05 00 - Common Work Results for Communications.

1.6 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 Ductbank Construction

A. PVC Conduit
1. Drawing and Spec Reference: PVC.
2. Construction:
a. 4" trade diameter, unless otherwise noted.
b. Poly-vinyl chloride.
c. Schedule by Application
i. Straight segments, Schedule 40.
ii. Elbows, Provide CRSC.
iii. Above grade, Schedule 80.
d. Elbows.
i. CRSC as specified in Section 27 05 33 – Communications, Raceways, Boxes and Fittings
ii. 90° C rated.
iii. Solvent welded joints, joints by pipe manufacturer.
e. Application.
i. Soil Backfill/Direct Burial
(1) RUS Type II, Type C or Type DB
(2) Schedule 40.
ii. Concrete Encasement:
(1) PVC Type DB-120,
(2) RUS Type I, Type B or Type EB
(3) Any meeting Soil Backfill/Direct Burial.
iii. Boring
(1) HDPE.
(2) RUS Type Flexible Plastic.
f. Performance:
i. Tensile Strength: 7,000 psi at 73.4° F.
ii. Flexural Strength: 11,000 psi.
iii. Compressive Strength: 8,600 psi.
g. Approvals:
i. RUS Listed for Telephone Cable Installation 5-99 Edition, or latest release thereof.
ii. NEMA TC-2, PVC Type EPC-40 and EPC-80.
iii. NEMA TC-3.
iv. NEMA TC14 Fiberglass Conduit.
v. UL 514 fittings.
vi. UL 651.
vii. ANSI C33.91.
h. Manufacturers:
i. RUS Listed:

Manufacturer	RUS Listed for	Manufacturer Part Number
Allwire, Inc.	Flexible plastic	ALLDUCT
American Pipe & Plastics	Plastic	Type B, C, and D
	Plastic	Type EB and DB

Manufacturer	RUS Listed for	Manufacturer Part Number
	Plastic	PVC Multi-Duct (2,3,4 and 6-way)
Americon International	Flexible plastic	HDPE Duct
	Plastic	PVC Type C
Apache Plastics, Inc.	Plastic	Type EB and Type DB
ARMCO	Plastic	Smooth-Cor Type B and Type C
Arnco	Flexible plastic	HDPE Conduit
Bay Plastics, Inc.	Plastic	Type B and Type C
Bristolpipe	Plastic	Type B, C, and D
	Plastic	Type EB and Type DB
Can-Tex	Plastic	Type EB and Type DB
	Plastic	Type B, C, and D
Carlon	Plastic	Type EB and Type DB
	Plastic	Type B, C, and D
	Plastic	Multi-Gard
Certain-Teed Products Corp.	Plastic	Type EB and Type DB
CIBA-GEIGY	Fiberglass	T & D Conduit
Condux International, Inc.	Concrete	Condux
	Plastic	Type EB and Type DB
CSR Polypipe	Flexible plastic	HDPE Duct
Dura-line	Flexible plastic	HDPE Duct
Eagle Pacific Industries, Inc.	Plastic	Type EB and Type DB
	Flexible plastic	HDPE Coiled Duct
Endot Industries	Flexible plastic	HDPE Duct
Freedom Plastics, Inc.	Plastic	Type C
Hercules, Inc.	Flexible plastic	Corflo plastic conduit
Hurlbut Plastic Pipe	Plastic	Type C
Ingomar Plastic Pipe	Plastic	Type B and Type C
J-M Manufacturing Company	Plastic	Types C, EB, and DB
Kyova	Plastic	Type EB and Type DB
LCP National Plastics, Inc.	Plastic	Type EB and Type DB
	Plastic	Type B and Type C
Northern Pipe Products	Plastic	Type B, C, and D
OMNI	Flexible plastic	HDPE Duct
Petroflex	Flexible plastic	HDPE Duct
	Flexible plastic	Corrugated HDPE Duct
Phillips Products Co., Inc.	Flexible plastic	Driscon 3200

Manufacturer	RUS Listed for	Manufacturer Part Number
Phone Ducs	Plastic	Multiple plastic conduit (4, 6, & 9 Way)
PLEXCO	Flexible plastic	PLEXCO Duct
PWPipe	Plastic	Type EB and Type DB
Pyramid Industries, Inc.	Plastic	Type EB and Type DM
	Flexible plastic	HDPE Conduit
Quail Plastics	Plastic	Type EB and Type DB
Queen City Plastics	Plastic	Type EB and Type DB
River City Plastics	Plastic	Type EB and Type DB
Sedco	Plastic	Type EB and Type DB
Southern Pipe, Inc.	Plastic	PVC Types EB, DB, and Sch. 40
Tamaqua Cable Products	Flexible plastic	HDPE Duct
Tridyn Industries	Plastic	Type EB and Type DB
Vassallo Industries	Plastic	Type B and Type C
Wesflex	Flexible plastic	Flex-Con

ii. or equal

B. Fiberglass Conduit
1. Drawing Reference: Fiberglass
2. Construction:
   a. Trade Standard Sizes
   b. Meets NEMA TC 14
   c. Complete system of joints and threaded steel conduit couplers
3. Manufacturers:
   a. TVC Communication/Vikimatic Fiberglass Conduit
   b. Champion Fiberglass
   c. FRE Composite
   d. or equal.

C. Coated Rigid Steel Conduit:
1. Drawing and Spec Reference: CRSC.
2. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
3. Fittings:
   a. Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.
   b. Fittings over-sleeve to extend 1 conduit diameter or 1-1/2" beyond fitting, whichever is less.
4. Performance:
   a. Tensile Strength: 3500 psi.
5. Approvals:
   a. NEMA RN1 (Type 40 - 40 mils thick)
   b. CalTrans Type 2
6. Manufacturers:

a. Plastibond by RobRoy Industries.
b. Occal-40 by Occidental Coating Company.
c. KorKap by Plastic Applicators.
d. Ocal-Blue
e. or equal.

D. Refer to Section 27 05 33 – Communications, Raceways, Boxes and Fittings for additional ductbank construction products.

2.2 Fittings

A. Couplings, adaptors, transition fittings, etc., shall be molded PVC, slip on, solvent weld type conforming to NEMA TC3 for Schedule 40 or 80 and NEMA TC 9 for type EB or DB.

B. Fitting Types
1. Expansion Fittings, 12”, Metallic:
2. Function: At road or bridge expansion joints requiring up to 12” of expansion compensation.
3. Approvals:
a. CalTrans
4. Construction
a. Steel, hot dip galvanized.
b. Nylon wear bushings
c. O-ring seal
d. Bonding jumper
5. Manufacturers:
a. O-Z Gedney Type AX, Type AX-8, and Type EX fittings with Type BJ Bonding Jumper.
b. TVC/Vikimatic VB0285X series.
c. or equal.

C. Expansion Fittings, 6”, Non-metallic:
1. Function: At road or bridge expansion joints requiring up to 6” of expansion compensation.
2. Construction
a. Fiberglass
b. Provide bonding jumper.
3. Manufacturers:
a. TVC Communications HW or Extra Heavy Wall Expansion Joint.
b. Vikimatic
c. FRE Composites, Inc.
d. Or Equal.

D. Refer to Section 27 05 33 – Communications, Raceways, Boxes and Fittings for additional fittings.

2.3 Underground Structures

A. Vaults, PullBoxes and Manholes, Precast, General
1. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes, boxes and handholes.
2. Construction

a. General
   i. Castings shall be free from warp and blow holes that may impair strength or appearance.
   ii. Structures shall be precast to the design and details indicated, precast monolithically and placed as a unit, or structures may be assembled in sections, designed and produced by the manufacturer in accordance with the requirements specified.
   iii. Structures shall be identified with the manufacturer's name embedded in or otherwise permanently attached to an interior wall face.
   iv. Structure top and wall shall be of a uniform thickness of not less than 4 inches except at knockouts.
   v. The minimum concrete cover for reinforcing steel shall be 2 inches.
   vi. All steel, except reinforcing steel, shall be hot dip galvanized after fabrication.
   vii. Knockouts & Windows
      (1) Thin-walled knock-out panels designed for future duct bank entrances are permitted.
      (2) Sides of precast windows shall be a minimum of 4 inches from the inside surface of adjacent walls, floors, or ceilings.
      (3) Form of the perimeter of precast window openings to have a keyed or inward flared surface to provide a positive interlock with the mating duct bank envelope.
      (4) Provide welded wire-fabric reinforcing through window openings for in-field cutting and flaring into duct bank envelopes.
      (5) Provide additional reinforcing steel comprised of at least 2 No. 4 bars around window openings.
   viii. Extension Rings
      (1) Provide extension rings as-required to extend from finished grade to communications utilities.
   ix. Bottom and Drain Sumps
      (1) Provide solid concrete bottom surface.
      (2) Provide drain sumps for precast structures a minimum of 12 inches in diameter and 4 inches deep.

3. Joints:
   a. Provide tongue-and-groove or shiplap joints on mating edges of precast components.
   b. Design joints to firmly interlock adjoining components and to provide waterproof junctions, and adequate shear transfer.
   c. Seal joints watertight using preformed plastic strip conforming to AASHTO M198, Type B.
4. Frames and Covers
   a. Covers to match across all utilities.
   b. Provide fiber composite lids at pedestrian rated covers, H-20 steel

slip resistant covers otherwise.

c. Labeling
   i. Provide labeling as follows:
      (1) “Town of Colma Communications”
      (2) Owner's Manhole or Vault No, as shown on drawings or provided to Contractor prior to vault order placement.
   ii. Labeling shall be:
      (1) Cast in concrete lids
      (2) Written in weld on steel lids
      (3) Alternatively, for pedestrian grade vault lids and for the vault number only, provide 1/8” min. thickness lamacoid label, rivet attached to box top in recess area below surface of lid.

5. Pulling-In-Irons
   a. Steel bars bent in the form indicated and cast in the walls and floors.
   b. Install a pulling-in iron in the wall opposite each duct line entrance at walls, not less than 6 inches above or below, and opposite the conduits entering the manhole.
   c. Pulling-in irons shall project into the manhole approximately 4 inches, or be cast in a pocket. Iron shall be hot-dipped galvanized after fabrication.
6. Cable Racks and Arms
   a. Provide cable racks, including rack arms, minimum two (2) 12” arms each manhole or vault face.

B. Underground Pull Boxes and Vaults, Concrete
1. Drawing and Specification References:
   a. PB1P
   b. PB1T
   c. PB2P
   d. PB2T
   e. PB3T

2. Minimum Size
   a. As scheduled on the drawings. Provide scheduled or larger size.
3. Lid Construction:
   a. As scheduled on the plans
4. Cover Components
   a. PB1 and PB2 Size: One piece construction
   b. PB3 Size: Two piece hinged lids with torsion spring lifters.
5. Manufacturers:
   a. Brooks Products
      i. 1P & 1T: 5 Series and extension rings as required
      ii. 2P & 2T: 67 Series and extension rings as required
      iii. 3T: 400 Series with 11C Type Lid.
   b. Jensen PreCast
      i. PB1P: P9 with FL9D lid, P9BA base and extension rings as required.

ii. PB1T P9 with P9-61 lid, P9BA base and extension rings as required
iii. PB2P: P36 with FL36D cover, P36BA base and extension rings as required
iv. PB2T: P36 with P36-61D lid, P36BA base and extension rings as required
v. PB3T: 35TA

c. Utility Vault Company, Inc./Oldcastle Precast
i. PB3T: PTS-3660, with H-20-44 loading cover, with 3660-06 and 3660-12 extensions as required.

d. Associated Concrete Products
e. Forni Corporation.
f. Or equal.

2.4 Miscellaneous Underground Products

A. Cable Warning Tape
1. Minimum Features/Functions/Construction:
a. 6 inches wide minimum.
b. 5 mil plastic.
c. Metallic backing at least 10 feet o.c.
d. 1 mil metallic foil core.
e. Orange in color
f. Suitable for buried applications.
g. Continuously imprinted with the words "WARNING - COMMUNICATIONS CABLE BELOW" or similar at not more than 48 inch intervals.
2. Manufacturers:
a. Carlon Telecom Systems.
b. Monarch Duct &Conduit
c. Vikimatic
d. Or equal.

B. Pull Rope
1. Minimum Features/Functions/Performance/Construction:
a. At least 3/8 inch diameter polyethylene or 3/8” min width woven aramid fiber pulltape.
b. 200 pound minimum strength.
2. Manufacturers:
a. Arnco Dandy-Line
b. Carlon Telecom Systems.
c. Fibertek Pull-line
d. Monarch Duct & Conduit
e. Vikimatic
f. Any length marked tape specified elsewhere herein below constructed as a pulltape.
g. or equal.

C. Length Marked Tape
1. Minimum Features/Functions/Performance/Construction:
a. Provide 1/2 inch flat tape with sequential markings in whole feet.
2. Manufacturers:

a. Carlon Telecom Systems.
b. Greenlee
c. Fibertek Pulltape or Tracertape
d. Vikimatic
e. or equal.

D. Conduit Plugs and Caps, Underground Conduit Stubs
1. Minimum Features/Functions/Performance/Construction:
a. Universal blank duct plug type, with eye for tying rope and tape.
b. Provide at each location indicated for future expansion.
c. Wateright.
2. Manufacturers:
a. Carlon Telecom Systems Universal Blank Duct Plugs, Simplex, Triplex and Quadplex Duct Plugs
b. Condux International, Inc.
c. Monarch Duct & Conduit Duct Plugs and Multistep Cap Ends
d. GS Industries of Bassett, LLC Expandable Watertight Plugs
e. or equal.

E. Line Marker Post
1. Minimum Features/Functions/Performance/Construction:
a. Orange polyethylene, post height 4 feet above surface.
b. Soil anchor.
2. Manufacturers:
a. Carlon Telecom Systems.
b. Vikimatic
c. Or equal.

F. Conduit Spacer, Trench
1. Minimum Features/Functions/Performance/Construction:
a. Non-metallic.
b. Sized to snap around conduits as shown on Drawings.
c. Interlocking.
2. Manufacturers:
a. Underground Devices Wunpeece.
b. GS Industries of Bassett, LLC Underground Products Spacer System.
c. Armorcast Products Company
d. Carlon Snap-Loc Spacers
e. or equal

G. Pulling In Irons
1. Minimum Features/Functions/Performance/Construction:
a. 7/8" Diameter
b. 6" exposed length minimum after embedment
c. RUS approved
2. Manufacturer
a. Cooper Power Systems
b. Or equal by listed vault or maintenance hole manufacturer
c. Or equal.

H. Cable Racks & Supports
1. Minimum Features/Functions/Performance/Construction:
a. Non-metallic
b. 12" minimum rack arms

c. Snap into vertical strut sections provided with new manhole, pullboxes and vaults, or into Government's existing vaults, where indicated.

2. Approvals
   a. RUS
   b. NEMA
3. Manufacturers:
   a. Underground Devices
   b. or equal (no known equal)

PART 3 - EXECUTION

3.1 General Requirements

A. Refer to the most restrictive of the Code, the manufacturer's instructions, these specifications and the relevant NEMA, CalTrans or RUS guidelines and conform.

3.2 Conduit Application

A. General: Install the following types of conduits and fittings in the locations listed, unless otherwise noted in the drawings:
   1. Underground Ductbanks, Concrete Encased
      a. PVC – Straight Sections, CRSC – Elbows.
B. Exterior, Exposed:
   1. Type RSC for applications up to 8 feet AFF or to first pull box, whichever is first, applications subject to physical abuse or for applications greater than 4" diameter.
   2. EMT acceptable in all other applications not noted above up to 4", where used in conjunction with specified Raintight (compression) couplers.
C. Embedded in Concrete
   1. RSC or rigid non-metallic conduit.
   2. PVC

3.3 Raceway Installation, General

A. Refer to Section 27 05 33 – Conduits and Backboxes for Communications Systems

3.4 Underground Construction:

A. Duct and Conduit Placement.
   1. Duct lines shall have a continuous slope downward toward underground structures and away from buildings with a minimum pitch of 3 inches in 100 feet.
   2. Except at conduit vertical risers at the building entrance facility, make changes in direction of runs exceeding a total of 10 degrees, by long sweep bends having a minimum radius of curvature of all planes of 4 feet for all ducts 3" or larger in diameter.
      a. Vertical conduit risers at building entrances to provide a minimum of a 3 foot radius.

b. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
c. Bends shall have a minimum radius of 24 inches in all planes for ducts of less than 3 inches in diameter.

3. Maintain no more than 180 degrees of duct bend between pull points, including where work of the project extends existing ductbank. Provide a pullbox or manhole for each section of underground duct where the sum of the turns in along the pathway exceeds 180 degrees.
4. Excavate trenches along straight lines from structure to structure before ducts are laid or structure constructed so the elevation can be adjusted, if necessary, to avoid unseen obstruction.

B. Duct Bank.

1. Duct Entrance Arrangement - Conform to Table 3.27 and applicable arrangement diagrams 3.57-3.64 of 2004 BISCI Customer Owned Outside Plant Design Manual.
2. Terminate conduits in end-bells where duct lines enter underground structures.
3. Stagger conduit joints by rows and layers to strengthen the duct bank.
4. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly shall consist of base spacers, intermediate spacers and top spacers to provide a completely enclosed and locked-in duct bank. Install spacers per manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of duct bank. Before pouring concrete or backfilling, as applies, anchor duct bank assemblies to prevent the assemblies from floating. Anchoring shall be done by driving reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.
5. As each section of a duct line is completed from structure to structure, for conduit sizes 3 inches and larger draw a flexible testing mandrel approximately 12 inches long with a diameter less than the diameter of the conduit through a conduit. After which, draw a stiff bristle brush having the same diameter of the conduit through the conduit, until conduit is clear of particles of earth, sand, and gravel; then immediately install end plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through the conduit, until conduit is clear of particles of earth, sand, and gravel; then immediately install end plugs.
6. Unless otherwise noted, exterior communications conduit runs shall be buried a minimum of 36" below finished grade or as required to conform to local utility requirements. Where new trenching is required, backfill and compaction requirements shall be as defined in other Sections.
7. Where concrete encasement indicated, construct underground duct lines of individual conduits encased in concrete. Do not mix different kinds of conduit in any one duct bank. Ducts shall not be smaller than shown. The concrete encasement surrounding the bank shall be rectangular in cross-section and shall provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 2 inches, except separate light and power conduits from communications conduits by a minimum concrete thickness of 4 inches. The top of the concrete encasement shall not be less than 36 inches below grade except that under roads and pavement concrete be a minimum of 36 inches below

grade.

C. Where conduit runs under existing roads, cut and patch the pavement as indicated.

D. Conduit Plugs and Pull Rope. New conduit indicated as being unused or empty shall be provided with plugs on each end. Plugs shall contain a weephole or screen to allow water drainage. Provide a length marked tape and a nylon pull rope having 3 feet of slack at each end of unused or empty ducts provided under the work of this Project.

E. Partially Completed Duct Banks. During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, sand and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 1 foot apart. Restrain reinforcing assembly from moving during concrete pouring.

F. Connections to Existing Manholes. For duct line connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct line encasement. Chip out the structure wall to form a key for the duct line encasement.

G. Mark locations of future provision underground raceways by pre-cast reinforced concrete pullbox set flush in ground with stamped brass disk identification plate tied to conduit end with “Ty-Wrap”, “Quick-Wrap” or equal.

H. In existing facilities underground construction, the Contractor shall promptly repair any indicated utility lines or systems damaged by Contractor operations. Damage to lines or systems not indicated, which are caused by Contractor operations, shall be brought to the immediate attention of the Owner’s Representative. If the Contractor is advised in writing of the location of a non-indicated line or system, such notice shall provide that portion of the line or system with "indicated" status in determining liability for damages. In any event, the Contractor shall immediately notify the Owner’s Representative of any such damage.

I. At twelve inches below grade, place specified warning tape continuously.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provisions of:
   1. Flexible communications raceway connections to vibrating machinery
   2. Sealing of communications device boxes related installed in sound rated walls. Refer to the architectural plans and wall schedules - any walls identified with an STC rating are sound rated.
   3. Coordination of airtight installation requirements at Mechanical and Electrical Rooms and/or duct enclosures.

1.2 Related Work in Other Sections

A. Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
   1. Division 23
      a. Energy Management Panels mounted on vibrating equipment connected to the Communications Work.
   2. Division 26
      a. UPS equipment connected to the Communications Work.
      b. Section 27 05 33 - Conduits and Backboxes for Communications Systems

1.3 References

A. American National Standards Institute (ANSI)
   1. ANSI/UL 1479-2003 Fire Tests of Through Penetration Firestops
B. American Society for Testing and Materials (ASTM)
   1. ASTM E814-02 Standard Test Method for Fire Tests of Through Penetration Fire Stops.
C. Underwriters Laboratories, Inc. (UL)
   1. UL Fire Resistance Directories

1.4 Submittals

A. Comply with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 – Common Work Results for Communications.

PART 2 - PRODUCTS

2.1 Flexible Communications Connections:

A. Make communications connections to vibrating equipment flexible as follows:
   1. For conduit over 1" O.D. make communications connections to vibrating

equipment via a flexible expansion/deflection conduit coupling sized as required. Coupling shall have flexible and watertight outer jacket, internal grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with threads to fit standard threaded metal conduit.

2. Manufacturers:
   a. XD Xpansion Deflection Coupling by Crouse-Hinds of Syracuse, N.Y.
   b. Type DF Expansion and Deflection fitting by Spring City Electrical Mfg. Co.
   c. or equal.
3. For conduit under 1" O.D. utilize FLEX or LIQUIDTIGHT conduit as specified in Section 27 05 33 – Conduits and Backboxes for Communications Systems with slack at least 3' or 15 diameters long, whichever is the longer or provide a flexible coupling as defined above.

2.2 J-box Mastic:

A. At all electrical boxes, flush and semi-flush pull cans, media panel backboxes, device boxes and similar penetrating sound isolating partitions, utilize sheet form adhesive mastic to increase the mass of the enclosure through application to the entire concealed surface within the wall cavity.

B. Manufacturers:
   1. Insul-Pad by Dottie Corp.
   2. Duct-Seal by Gardner Bender, Inc.
   3. Duxseal by Manville
   4. Outlet Pad by Lowry
   5. or equal.

2.3 Resilient Penetrations:

A. For conduit:
   1. Sleeves: Sleeves of appropriate gage galvanized sheet metal shall be formed to at least the thickness of the penetrated construction and 3/4" to 1" larger in each cross-sectional dimension than the penetrating element.
      a. Manufacturers:
         i. Century-Line Sleeves by Thunderline Corporation
         ii. Custom by Contractor
         iii. or equal.
   2. Batt: Glass fiber of batt or mineral wool, 1 to 3 lb./cu. ft. density.
      a. Manufacturers
         i. Certain-Teed
         ii. Johns-Manville
         iii. Owens-Corning
         iv. or equal.
   3. Acoustical Sealant:
      a. Manufacturers
         i. DAP
         ii. Pecora
         iii. Tremco
         iv. U.S. Gypsum

v. or equal.

4. Firestop Sealant:
   a. Where required, resilient firestop caulking may be used in lieu of Acoustical Sealant when installed in strict conformance with the manufacturer's directions. Fully hardened firestop caulk shall develop a Shore A hardness of no greater than 35. Refer to the requirements of Section 27 05 33 – Conduits and Backboxes for Communications Systems.

PART 3 - EXECUTION

3.1 General Installation Requirements, Connection to Vibrating Equipment

A. The Contractor shall not install any vibrating equipment or conduit attached thereto which makes rigid contact with the "building" unless it is approved in this specification or by the Owner's Representative. "Building" includes, but is not limited to slabs, beams, columns, walls, partitions, ceilings, studs, ceiling framing and suspension systems.

B. Prior to installation, the Contractor shall bring to the Owner' Representative's attention any conflicts between trades which will result in unavoidable rigid contact at equipment, conduit, piping, ducts, etc., as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

C. The Contractor shall obtain inspection and approval from the Owner's Representative of any installation to be covered or enclosed, prior to such closure.

3.2 Inspection of Conditions:

A. Examine related Work and surfaces before starting Work of this Section. Report to the Owner's Representative, in writing, conditions which will prevent proper provision of this work. Beginning the Work of this Section without reporting unsuitable conditions to the Owner's Representative constitutes acceptance of such conditions by Contractor. Perform any required removal, repair, or replacement of this Work caused by unsuitable conditions at no additional cost to the Owner.

B. Coordination
   1. Coordinate with the work of the Base Building Construction Contract. Coordinate Work of this Section with all other impacted trades.

3.3 Installation Requirements, Flexible Electrical Connections

A. The installation of flexible electrical connections to vibration isolated equipment shall in no way impair or restrain the function of the vibration isolation installed by the work by Others.
   1. Using gross slack. Install flexible conduit in a grossly slack loop form or shallow "U" form. Install stranded conductors with sufficient slack to accommodate maximum possible movement.
   2. Using flexible coupling. The flexible coupling shall be free and not in contact with any nearby building construction and shall be installed slack,

and free of strain in any direction. Install stranded conductors as above

3.4 Installation Requirements, J-box Mastic

A. Application: All Communications Systems work in sound isolating assemblies, including but not limited to residential rooms, offices, mechanical rooms, electrical rooms and related to utilize backboxes for all services, including but not limited to low voltage communication. Installation of backboxes to conform with following:
   1. Space outlet boxes on opposite faces of the wall by more than 24" o.c. Where daisy chainned conduits indicated on the plans, connect such boxes by slack flexible conduit (2 times longer than distance between outlets).
   2. Cutouts for electrical boxes and penetrating piping/conduit shall be no more than 1/4" oversize.
   3. Caulk gap between drywall and electrical boxes and/or piping/conduit airtight with Acoustical Sealant. Apply J-Box mastic to back of all penetrating electrical boxes and press firmly at joint to wallboard to provide an airtight seal.

3.5 Installation Requirements, Resilient Penetrations

A. Penetrations included in this Section of the Specifications include all communications conduit connected to vibrating equipment within 30 feet of such equipment
B. Method for round or rectangular penetrations.
   1. Cut a clean opening in the penetrated construction very nearly the size of the sleeve for each penetrating element. Provide lintels above, relief structure below and vertical framing between and to the sides, as required. Provide the above, escutcheon plates and such related construction as is necessary to make the penetrated structure as solid and massive near the penetrations as the surrounding construction.
   2. Set the metal sleeve into the penetrated construction in an airtight manner around its outer periphery, using grout, dry packing, plaster or drywall compound full depth and all around - but only to a maximum width of ½" - or the requirements of the above paragraph shall not have been satisfied.
   3. Pack annular opening with glass fiber between metal sleeve and penetrating element full depth, all around to a firm degree of compaction. Leave a ½" deep annular opening free at each end of the metal sleeve; fill this fully with sealant.

3.6 Mechanical and Electrical Rooms Requirements

A. All mechanical and electrical rooms, plenums, duct shafts and drywall duct enclosures and other enclosures of high noise sources shall be constructed airtight. This means that every precaution shall be taken to maintain construction completely airtight around a room so designated. Construction joints, duct penetrations, electrical boxes, frames, supports, cabinets, doors, access panels, fixtures, etc., all shall be built or installed in such a manner as to prevent sound transmission through any construction enclosing a room horizontally or vertically. Appropriate lintels, frames, blocking, escutcheons, grouting, gaskets, packing, caulking, taping, filling, etc., all shall be employed to prevent sound transmission. Refer to requirements of this Section for Resilient Penetrations.

B. All work under this section is to comply with the above. Contractor to report to Owner's Representative any construction conditions which arise which might compromise compliance with this requirement.

END OF SECTION

PART 1 - GENERAL

1.01 Summary:

A. Provide all labor, materials, tools, and equipment required for permanent intelligible labeling on, or adjacent to, all cabling, connectors, innerduct, faceplates, jacks, receptacles, controls, fuses, circuit breakers, patching jacks, and racks.
B. This section includes minimum requirements for the following:
   1. Communications Cabling
   2. Closet Hardware including patch panels, terminal blocks, protectors and racks
   3. Work Area Outlets
   4. Wireless Access Points
   5. Underground Vaults
   6. Pathways, Spaces, Grounding and Bonding.
C. Refer to detailed plans for additional requirements.
D. Clearly and distinctly indicate the function of the item.
E. Coordinate with Record Drawings

1.02 References:

A. Usage: In accordance with Section 01 41 00 – Regulatory Requirements.
B. American Society for Testing and Materials (ASTM)
   1. ASTM D 709(2001) Laminated Thermosetting Materials
C. Electronic Industries Alliance (EIA)
   1. EIA TIA/EIA-606-A(2002) Administration Standard for Commercial Telecommunications Infrastructure (ANSI/TIA/EIA-606)
D. Underwriters Laboratories (UL)
   1. UL 969 (1995; R 2001) Marking and Labeling Systems

1.03 Quality Assurance

   1. ANSI/TIA/EIA-606-A-2002, Administration Standard for Commercial Telecommunications Infrastructure.
   2. ANSI/TIA/EIA – 569B Pathway and Spaces
   3. ANSI/TIA/EIA – 568C Telecommunications Cabling Standard.
   4. BICSI Telecommunications Distribution Methods Manual.
   5. UL 969 (1995; R 2001) Marking and Labeling Systems.
A. City Standards
   1. All new labeling is to reflect Town of Colma labeling and cable identification standards. Contact the Owner's Representative for a copy of the current standards prior to proceeding. In the event no standard is available, Contractor to label station cabling per this specification and the device schedule provided with Construction Documents and to propose a labeling standard for AV cabling that uniquely identifies each cable.
   2. Bring to the Owner Representative's attention any project conditions not described in these specifications and the Owner's current standards, and conform with the direction received.

1.04 Submittals

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.05 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

1.06 Sequencing

A. Not Used.

PART 2 - PRODUCTS

2.01 Communication Cabling Labels, Interior

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
C. Provide vinyl substrate with a white printing area and black print. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
D. Shall be flexible vinyl or other substrates to apply easy and flex as cables are bent.
E. Shall use aggressive adhesives that stay attached even to the most difficult to adhere to jacketing.
F. Manufacturers:
    1. Cable Type – Silver Satin
        a. Panduit S100X125VAC
        b. or equal.
    2. Cable Type – 4 pair UTP / 4 pair UTP Zero Skew
        a. Panduit S100X125VAC
        b. or equal.
    3. Cable Type – 4 pair STP
        a. Panduit S100X125VAC
        b. or equal.
    4. Cable Type – 25 pair copper
        a. Panduit S100X650VAC
        b. or equal.
    5. Cable Type – 50 pair copper
        a. Panduit S100X650VAC
        b. or equal.
    6. Cable Type – 100 pair copper
        a. Panduit S100X650VAC
        b. or equal.
    7. Cable Type – 2 strand fiber
        a. Panduit F100X300AJT

b. or equal.

8. Cable Type – 4-12 strand fiber
   a. Panduit S100X125VAC
   b. or equal.
9. Cable Type – RG-6 Coax
   a. Panduit S100X125VAC
   b. or equal.
10. Cable Type – RG-59 Coax
   a. Panduit S100X125VAC
   b. or equal.
11. Cable Bundles
   a. Panduit UIHL12-X0
   b. or equal.
12. Other Interior Cabling
   a. Panduit S100X650VAC
   b. or equal.

2.02 Communications Cable Labels, Outside Plant

A. Cable Tags in Manholes, Handholes, and Vaults
   1. Provide tags for communications cable or wire located in manholes, handholes, and vaults.
      a. The tags shall be polyethylene.
      b. Machine printed - Do not provide handwritten letters.
   2. Polyethylene Cable Tags
      a. Provide tags of polyethylene that have an average tensile strength of 3250 pounds per square inch; and that are 0.08 inch thick (minimum), non-corrosive non-conductive; resistive to acids, alkalis, organic solvents, and salt water; and distortion resistant to 170 degrees F.
      b. Provide 0.05 inch (minimum) thick black polyethylene tag holder.
      c. Provide a one-piece nylon, self-locking tie at each end of the cable tag.
      d. Ties shall have a minimum loop tensile strength of 175 pounds. The cable tags shall have black block letters, numbers, and symbols one inch high on a yellow background.
      e. Letters, numbers, and symbols shall not fall off or change positions regardless of the cable tags' orientation.
   3. Manufacturers:
      a. Panduit M200X100YLT
      b. or equal.

2.03 Closet Hardware Labels

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
C. Where insert type labels are used provide clear plastic cover over label.
D. Manufacturer:

1. Copper Patch Panels
   a. 4 port group
      i. Panduit C25X030FJC.
      ii. or equal.
   b. 6 port group
      i. Panduit C390X030YIC
      ii. or equal.
   c. Individual port
      i. Panduit C25X030FJC..
      ii. or equal
   d. Patch Panel Name Label.
      i. Panduit C125X030FJC.
      ii. or equal.
2. Non-keystone based fiber patch panels
   a. Panduit C25X030FJC.
   b. as provided with Patch Panel by the manufacturer
   c. or equal.
3. 110 blocks
   a. Panduit C750X050YIC.
   b. or equal.

2.04 Grounding and Bonding, Pathway, and Space Labels

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
C. Manufacturers:
   1. Panduit C200X100FJC.
   2. or equal.

2.05 Workstation Labels

A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
C. Location ID
   1. Manufacturers:
      a. Panduit .3” White C061X030FJC
      b. Panduit .5” White C750X050YIJ
      c. or equal.
D. Outlet /Jack ID
   1. Manufacturers:
      a. Panduit .3” White C138X019FJC
      b. Panduit .5” White C750X050YIJ
   2. or equal

2.06 Nameplates

A. Field Fabricated Nameplates
1. Features/Function/Construction
a. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
b. Comply with ASTM D 709.
c. Each nameplate inscription shall identify the function and, when applicable, the position.
d. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core.
e. Surface shall be matte finish.
f. Corners shall be square.
g. Accurately align lettering and engrave into the core.
h. Minimum size of nameplates shall be one by 2.5 inches.
i. Lettering shall be a minimum of 0.25 inch high normal block style
2. Manufacturers:
a. Panduit C300X100APT
b. or equal.

PART 3 - EXECUTION

3.01 General

A. Verify all room numbers, facility names, building numbers, and utility vault numbers with the Owner's Representative prior to labeling. Contractor applied labeling shall reflect final space and Telecommunications structure designations.
B. Contractor will be required to coordinate the labeling with the Owner's Representative and make adjustment where / when necessary at Contractor's expense when submittals and approvals are not received in advance.
1. Where circuit numbers are indicated on the Contract Documents, Contractor to apply those numbers after first confirming that they remain consistent with the Owner's current standards.
C. Label cables using the appropriate circuit ID. Label to be Black text on a White background.
D. Use adhesive type labels for all interior communications cable labels.
E. Affix labels to cables – marking cable or other non-machine generated means is not permitted.
F. Apply labeling to clean surfaces free of oil, dust, solvents or loose material.
G. Apply after Project painting in area of application is complete.
H. All jack, patch panel and WAP labels to be sized to match available label locations, labeling windows, pre-defined labeling areas of components unless otherwise directed by the Owner's Representative.
I. Cable designation, cable numbers, locations and a running tally of installed cabling shall be continuously updated in each Telecommunications Room during the installation process.
J. Apply to locations where labeling will not be damaged, covered over or in the way of the ordinary maintenance and operation of the installed Telecommunications infrastructure or system.

K. Apply labeling right side up, parallel to major edges of surfaces to which it is applied. When no line is evident, apply parallel to floor line. Correct conditions of labeling applied out of true.
L. Protect installed labeling from damage.
M. Replace labeling that is defaced, faded, illegible or peeling off of the surface to which it is applied.
N. Provide all label information on new layer(s) of respective AutoCAD drawings for each cable, equipment and device being installed.

3.02 Identification and Labling

A. Telecommunications Rooms
1. Labels shall be affixed at the entry to all telecommunications rooms and spaces (Includes entrance facilities, telecommunications equipment rooms, communication equipment spaces and work areas)
2. Affix labels to entrance doors – coordinate location with Owner's Representative.
3. At each Telecommunications Room, a copy of the as-built record drawing for the cabling served by the room prepared using Computer Aided Drafting (CAD) to be plotted on an architectural “D” or “E” size on Mylar sheet(s) and permanently fastened to the wall at a location selected by the Owner's Representative.

B. Rack & Cabinet Labeling
1. Label per the City labeling standard.
2. Acceptable methods are White or Black paint (Gray and aluminum racks shall have black lettering, Black racks shall have white lettering) the largest lettering allowable on the foot of the rack being installed. Letters may also be stamped into the footing of the rack in the same size range. Acceptable sizes are 2, 3 or 4 inch letters.

C. Underground Structure including Maintenance Holes, Vaults, Boxes and Underground Vault locations
1. All maintenance holes, vaults and pullboxes must be labeled with a unique number defined by the CAD files and spreadsheet provided by the Owner’s Representative.
2. The unique number or identifier must be clearly stamped into the rim or frame of all manholes, vaults and pullboxes. It must be weatherproof, wear-proof, legible, and visible at all times.
3. All pull through locations that have no ring to identify shall have a stamped plate attached that provides an identifier that is identical to that of a stamped ring.
4. The number or identifier must be the largest font size that the installer can fit into the rim or frame.
5. The labeling is to be placed on the South side of the Manhole, Vault and/or Pullbox.
6. The labeling effort is the direct responsibility of the installing contractor placing cabling within a vault, manhole, pullbox structure.

D. Outside Plant Cabling
1. Within every manhole/vault/pullbox and within 4 ft of the entrance into a building every backbone cable’s assigned identifier shall be affixed to either the cable’s outer jacket or to innerduct in which the cable is

installed.

2. Label each building to building cable traversing outside the structure with a unique number. A spreadsheet containing the circuit number to be applied to each cable will be provided by the Owner's Representative.
3. Locate labels to maximize viewing by service personnel. If several cables are bundled together or run side-by-side, group all labels.
4. Where the cables terminate indoors in Entrance Facilities, use the methods described under Indoor Communications Cables below.

E. Indoor Communications Cables

1. Horizontal and Indoor Backbone Cables shall be marked within 12” of each endpoint or to innerduct in which the cable is installed. Label each end of each riser cable where the cable terminates according to the scope of work. Backbone cables shall be marked at each endpoint and at all intermediate locations, pull / access points or junction boxes through which the cable passes, as well as on each floor and in each room the cable is openly visible in.
2. Cable label will be cut and sized to the cable's outer sheath.
3. Locate labels to maximize viewing by service personnel. If several cables are bundled together or run side-by-side, group all labels.
4. Copper Riser Cabling. Labeling of all copper backbone cables of at least 25 pair construction to contain the following information:
   a. Contractor's Name.
   b. Installation Date
   c. Cable Type (Example: CMP/24 AWG).
   d. Owner Assigned Cable ID: (Example: 70 Tie 0P609).
   e. Pair Count (Example: 1-50).
5. Fiber Riser Cabling. Labeling of all fiber backbone cables to contain the following information:
   a. Contractor's Name.
   b. Installation Date
   c. Cable Type (Example: OCNP/06 MM/SM).
   d. Owner Assigned Cable ID: (Example: IFA134).
   e. Strand Construction and Count (SM-1-12).

F. Fiber Patch Panels

1. Fiber patch panels shall be marked using adhesive labels indicating the range of circuits installed to it. All fiber optic cable patch panels shall be labeled with both the pair count of every fiber pair, the cable’s assigned identifier, and where shown on the plans, the patch panel's assigned identifier.
2. All labels shall consist of the following:
   a. Provide the respective FTU # next in sequence in the data room.
   b. Provide and label each bulkhead in the fiber panel per the following:
      i. Fiber Cable # "FROM" Building / "FROM" Room / "FROM" FTU / Fiber Type / Strand # to Location / Telecom Cable # / "TO" Building / "TO" Room / "TO" FTU / Fiber Type / Strand #

G. Copper Patch Panels

1. If not shown on the Contract Documents, Owner's Representative will provide specific circuit ID information.

2. Category rated patch panels shall be labeled with an identifier, individual ports shall be labeled to indicate circuit and identification of station plate in which the circuit terminates.
3. Analog Voice patch panels, where indicated,
   a. Label the pair count at the top of the patch panel, separated from all others. Place the cable's identification text (example: 18CA75, TIE 1672A) centered on the top label strip.
4. Other Tie Cable Patch Panels
   a. Provide patch panel labels indicated its function.
   b. Example: " 70 TIE 1P176" Tie cable labels will be provided by the Owner's Representative.

H. 110 blocks
1. Each cable termination position on 110 blocks shall be labeled with number designators.
   a. All backbone copper cable termination blocks shall be labeled with both the pair count of every 5th pair and the cable's assigned identifier.
2. Where insert type labels are used install clear plastic cover over reprinted or Laser printed type label.

I. Workstations
1. Label per Owner's labeling standard.
2. For faceplates where insert type labels are used install clear plastic cover over preprinted or Laser printed type label.
3. For faceplates without insert type labels use adhesive type labels affix labels to faceplate at the top-left corner of the outlet device after mounting outlet into position.
4. Patch cords installed under the work of this Project shall be labeled at each endpoint using the appropriate circuit ID.

J. Special Phone Applications:
1. All Alarm, Wall Phone, House Phone, Pay Phone and other similar services requiring a cable and jack to be labeled consistent with data cables.

K. Grounding and Bonding
1. The TMGB (telecommunications main ground busbar) shall be labeled as such with an adhesive type label affix label to TMGB.
2. The conductor connecting the TMGB (telecommunications main ground busbar) to the ground busbar at the main building electrical service entrance to the building shall be labeled at each end with an affixed label in a visible location as close as practical to the bonding point at each end of the conductor by the Electrical Contractor.
3. The TGB(s) (telecommunications ground busbar) shall be labeled as such with an adhesive type label(s) affix label(s) to TGB.

L. Firestopping
1. Each firestopping location shall be labeled at each location where firestopping is installed, on each side of the penetrated fire barrier, within 12 in. of the firestopping material.

END OF SECTION

PART 1 - GENERAL

1.1 Scope of Work

A. This Section defines commons means and methods for the work of the following Sections:
   1. Section 27 11 13 – Communications Entrance Protection
   2. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
   3. Section 27 11 19 – Communications Termination Blocks and Patch Panels
   4. Section 27 11 23 – Communications Cable Management
   5. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
   6. Section 27 13 00 – Communications Interior Backbone Cabling
   7. Section 27 14 00 – Communications Outside Plant Backbone Cabling
   8. Section 27 15 00 – Communications Horizontal Cabling

1.2 Related Documents

1. Section 27 05 00 – Common Work Results for Communications applies to the work of this Section.
2. Section 27 05 26 – Grounding and Bonding for Communications Systems
3. Section 27 05 29 – Hangers and Support for Communications Systems
4. Section 27 05 53 – Identification for Communications Systems

1.3 References

A. Usage: In accordance with Section with Section 01 42 00 - References

B. In Addition to the requirements of Section 27 05 00 – Common Work Results for Communications, conform to the applicable portions of the following standards agencies:
   1. American Society For Testing and Materials (ASTM)
      a. ASTM A228/A228M-02 Steel Wire, Music Spring Quality.
   2. Bellcore
      a. TR-NWT-000253Intermediate Reach, 1,OC3
   3. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA)
      a. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA)
      b. TIA J-STD-607-A (2002) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
      c. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard, 2009
      d. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, published 2009
      e. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, published 2008, including errata issued in October, 2008.
      f. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure

g. ANSI/ TIA/ EIA 569-B Commercial Building Standard for Telecommunications Pathways and Spaces
h. ANSI/TIA-569-C (2012) Telecommunications Pathways and Spaces

4. Federal Communications Commission (FCC)
   a. The Code of Federal Regulations, Title 47, Telecommunications, Chapter 1 - FCC Part 68 (1982 issue or latest revision) (47 CFR 68) .
5. Institute of Electrical and Electronic Engineers
   a. IEEE 383-2003 Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations
   b. IEEE 100-00 The Authoritative Dictionary of IEEE Standards Terms
6. Insulated Cable Engineers Association (ICEA)
   a. ICEA S-56-434 (1983, 5th Ed.) Polyolefin Insulated Communication Cables for Outdoor Use.
   b. ICEA S-83-596(2001) Fiber Optic Premises Distribution Cable
   c. ICEA S-90-661(2002) Category 3, 5 and 5e Individually Unshielded Twisted Pair Indoor Cables With or Without Overall Shield for use in General Purpose and LAN Communications Wiring Systems – Technical Requirements
7. National Electrical Manufacturers Association (NEMA)
   a. NEMA WC 63.1(2000) Twisted Pair Premise Voice and Data Communications Cables
8. National Fire Protection Association (NFPA)
   a. NFPA 70 National Electrical Code
9. Underwriters Laboratories, Inc. (UL)
   a. UL 444(2002; Bul. 2002, 2003) Communications Cables
   b. UL 910(1998) Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
   c. UL 1286(1999; R 2004) Office Furnishings
   d. UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords. Oct. 2001
   e. UL 1666(2000; R 2002) Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
   f. UL 1863(2000; R 2004) Communications Circuit Accessories

1.4 Definitions

A. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in
   1. ANSI/TIA-568-C.0
   2. ANSI/TIA-568-C.1
   3. ANSI/TIA-568-C.2,
   4. ANSI/TIA-568-C.3,
   5. EIA TIA/EIA-569-C,
   6. EIA TIA/EIA-606-B and
   7. IEEE Std 100 and
   8. in this Section.

B. Building Distribution Frame (BDF) - Building Distributor (BD). A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

C. Floor Distributor (FD) - A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

D. Intermediate Distribution Frame (IDF) – See Telecommunications Room

E. Telecommunications Room (TR) - An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

F. Entrance Facility (EF) (Telecommunications) An entrance to the building for both private and public network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

G. Entrance Room (ER) (Telecommunications) - A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

H. Open Cable - Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

I. Open Office - A floor space division provided by furniture, movable partitions, or other means instead of by building walls.

J. Pathway - A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.5 Submittals

A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.6 Delivery, Storage, and Handling

A. Comply with requirements of Section 01 61 00 - Product Requirements, Section 27 05 00 – Common Work Results for Communications Systems and the following:

B. Shipping Conditions:
1. All cable shall be shipped on reels or manufacturer supplied “handy boxes”.
2. The diameter of the drum shall be at least 13 times the diameter of the cable.
3. The reels shall be substantial and so constructed as to prevent damage during shipment and handling.
4. Secure the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit.

5. Project the inner end of the cable into a slot in the side of the reel, or into a housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.
6. The inner end shall be fastened so as to prevent the cable from becoming loose during installation. End seals shall be applied to each of the cables to prevent moisture from entering the cable.

C. Storage:
1. Retain factory cable protection until installation. Supplement with heavy gauge plastic sheeting if factory protective membrane is pierced prior to installation. Tape ends and seams water and dust tight.
2. The reels with cable shall be suitable for outside storage conditions when the temperature ranges from minus 40 degrees C to plus 65 degrees C, with relative humidity from 0 to 95 percent.
3. Protect cable reels from physical damage from site construction vehicles or from settling into the soil.
4. Equipment, other than cable, to be delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.7 Sequencing

A. Not Used.

1.8 Performance Standards

A. Telephone (Voice) Copper Cabling Plant:
1. Suitable for direct connection to the Public Switched Network in accordance with rules set forth by FCC Part 68, California Public Utilities Commission, and other Authorities Having Jurisdiction.
2. Category 3 as defined in TIA/EIA-568-C.2

B. Horizontal (Station) Category 6 Copper Cabling – Permanent Link
1. Testing shall commence while the Owner's equipment in the area of service is operational and creating worst case emissions associated with its operation while in good working order. Every effort shall be made to include worst case influence on the materials install shall be taken.
2. In accordance with the field test specifications defined in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard”, every horizontal station cabling link in the project shall be tested for:
   a. Wire Map
   b. Length
   c. Insertion Loss
   d. NEXT Loss
   e. PS NEXT Loss
   f. ACR-F Loss
   g. PS ACR-F Loss
   h. Return Loss

i. Propagation Delay
j. Delay Skew

3. Using the listed Category 6 cable test set, test installed cabling using Permanent Link procedure and submit report demonstrating that the link meets the following parameters:

Frequency (MHz)	*Insertion Loss*	*NEXT (Worst pair to pair)*	*Power Sum NEXT*	*ELFEXT (Worst pair to pair)*	*Power Sum ELFEXT*	*Return Loss*
1.0	2.0	79.3	77.3	72.8	69.8	20.0
4.0	3.8	70.3	68.3	60.7	57.7	23.6
10.0	5.9	64.3	62.3	52.8	49.8	26.0
16.0	7.5	61.3	59.3	48.7	45.7	26.0
20.0	8.4	59.8	57.8	46.7	43.7	26.0
31.3	10.6	56.9	54.9	42.9	39.9	25.0
62.5	15.3	52.4	50.4	36.8	33.8	23.5
100.0	19.7	49.3	47.3	32.8	29.8	22.5
150.0	24.7	48.7	44.7	29.3	26.3	21.6
200.0	29	44.8	42.8	26.8	23.8	21.0
250.0	32.6	43.3	41.3	24.8	21.8	20.5

a. Each permanent link shall demonstrate a positive PSACR beyond 350 MHz to meet and exceed the bandwidth requirements of TIA-568-C.2 Category 6 standards. Each permanent link shall demonstrate 2 dB of cross talk headroom over TIA -568-C.2 Category 6 standard for NEXT, PSNEXT, ELFEXT and PSELFEXT bit error rate.

4. Report whether tested link passes or fails
5. Note exceptions to required Category standards. Remedy and retest.

C. Fiber Optic Cabling

1. Optical Budget, any end to end link not to exceed the sum of the following:
   a. Optical fiber loss.
   b. Splice loss.
   c. Connector loss.
2. Optical fiber loss shall be the optical fiber specified cable performance, pro-rated for total link distance.
   a. Fiber Loss, Multimode, not to exceed:
      i. At 850 nanometers, 3.5 dB per Kilometer.
      ii. At 1300 nanometers, 1.5 dB per Kilometer.
   b. Fiber Loss, Singlemode, Outside Plant Cable, not to exceed:
      i. At 1310 nanometers, 0.5 dB per Kilometer.
      ii. At 1550 nanometers, 0.5 dB per Kilometer.
   c. Fiber Loss, Singlemode, Inside Plant Cable, not to exceed:
      i. At 1310 nanometers, 1.0 dB per Kilometer.

ii. At 1550 nanometers, 1.0 dB per Kilometer.

3. Splice Loss
   a. Multimode
      i. 0.15 dB for each fusion splice
   b. Single Mode
      i. 0.06 dB for each fusion splice
4. Connector Loss
   a. Multimode
      i. 0.75 dB for each mated pair of type SC, Ultra Polish Connector.
   b. Single Mode
      i. 0.60 dB for each mated pair of type SC, Ultra Polish Connector.
      ii. 0.30 dB for each mated pair of type SC, Angle Polished Connector.

1.9 Testing

A. General
1. Test and report on each intermediate cabling segment separately, including station cabling, horizontal distribution (each segment, if multiple) and telecommunications room wiring.
2. Test each end to end cable link.
3. Submit machine-generated documentation and raw data of all test results on Contractor-provided, and Owner's Representative approved, forms; and in electronic format approved by the Owner's Representative.
4. Provide machine-generated data on an appropriate disk media (CD-ROM CD-R format) to be transferred to the Owner's computers.
   a. Where the machine-generated documentation requires use of a proprietary computer program to view the data, provide the Owner with 1 licensed copy of the software.
5. Provide registered testing software used for the actual tests to the Owner for review of test data.

B. Test Equipment:
1. Provide in conformance with the applicable requirements of 27 05 00 - Common Work Results for Communications .
2. Test systems using at least one (1) each of the following test measurement devices or their functional equivalents:
   a. Level III field testers as defined in ANSI/TIA-1152 - Fluke DX-1800, or equal.
      i. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 4 of ANSI/TIA-1152
      ii. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.

iii. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

b. Outside Plant Voice Cabling Plant tester - capable of detecting shorts, opens, reversals, mis-wiring and crosstwists. (Siemon STM-8, Fluke or equal).

c. Tone Test Sets.

d. Optical Power Meter (Corning Cable Systems, Fluke or equal)

i. Minimum Performance - Multimode Power Meter

(1) 850nm and 1300nm +/- 20 nm wavelength LED light sources.

(2) Spectral width of sources shall be </= 50nm for 850nm wavelengths and </= 140nm for 1300nm wavelengths.

(3) Output Stability +/- 0.40 dB from 0 to 50 degrees C

(4) Long Term output stability +/- 0.10dB at 25 degrees C

(5) Connector types to include: LC, ST and SC.

ii. Minimum Performance - Single Mode Power Meter

(1) 1300nm and 1500nm +/- 20 nm wavelength Laser light sources

(2) Output Stability +/- 0.40 dB from 0 to 50 degrees C

(3) Long Term output stability +/- 0.10dB at 25 degrees C

(4) Measurement range shall be from 10 to -60 dBm

(5) Accuracy shall be +/- 5% at 0 to -50dBm and +/- 10% 10 to 0dBm and -50 to-60 dBm.

(6) Resolution shall be 0.1 dB

(7) Connector types shall include: LC, ST, SC.

e. Optical Time Domain Reflectometer. (Fluke, JDSU or equal).

f. Site portable communications systems (walkie-talkie, cell phone or similar to aid in communications between test device locations).

g. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.

C. Station Wiring, General

1. Test station wire only after all pairs of station wire in a work area have been terminated at both ends, and no work of this Section or other Sections may cause physical disturbance to the wiring.

2. Correct any and all transpositions found. Retest.

3. If any conductor in a station wire tests either open or short, then the entire station wire is to be removed, replaced, and re-tested.

D. Inside Category 6 Cabling.

1. Using the listed Category 6 cable test set, test and submit report on the parameters specified for Category 6 cabling in this Section. Report whether tested link passes or fails the Category 6 standards in Part 2 of this Section.
2. Note exceptions to required Category standards. Remedy and retest.

E. Telephone: Outside Plant, Inside Riser Wire:
1. General:
   a. A new cable shall be tested only after all wires within the cable have been terminated at both ends.
   b. For unshielded cable, "measurements to ground" means an electrical connection to the Telecommunications Ground Bus, or building steel.
   c. The Contractor shall correct all defects possible.
   d. If the maximum number of unrepairable defective pairs exceeds 4% of the cable's pair count, the cable shall be deemed unacceptable and shall be replaced. Replace, re-terminate and retest new cable at no additional cost to the Owner.
2. Test procedures:
   a. TEST #1 – Continuity:
      i. Meter set for 20 ohm full scale ohm reading. Each pair shall be shorted at one end and the loop resistance value read at the other.
      ii. The difference between the largest and the smallest resistance reading from each pair in the cable shall be no more than 10 percent of the largest reading.
   b. TEST #2 - Balance, Polarity and Conductor Transpositions:
      i. Upon passing Test #1, the tester at one end of cable shall ground tip side of each pair in turn. The tester at other end of cable reads resistance to building ground of same conductor.
   c. REQUIREMENT: Reading for each tip conductor in pair of approximately one-half the loop resistance value from Test #1.
3. Test Report:
   a. Submit Test Report. Documentation shall include loop resistance regarding any opens, shorts, transpositions found, as well as corrective action taken to correct any found opens, shorts, or transpositions.

F. Fiber Optic Cabling.
1. Perform fiber optic cable testing on all installed fiber optic cabling. Submit test results. Notify Owner’s Representative in writing at least 72 hours in advance that fiber optic cable testing shall commence. Submit calibration certification for testing equipment to be used.
2. Submit test report no later than five days after the cables are tested.
3. Test and submit Power Meter attenuation assessments test results on each fiber, in each cable, and in both directions under final installation conditions. Submit with the following information:
   a. Date of test
   b. Name of test personnel
   c. Fiber cable type and part number
   d. Fiber number
   e. TX wavelength

f. TX location
g. RX location
h. TX model and serial number
i. RX model and serial number
j. Attenuation in dB

4. Acceptance Tests
   a. Power Meter Attenuation Test
      i. Perform on all fiber cabling segments.
      ii. Method: Perform the following measured attenuation tests using the method B of ANSI/EIA/TIA-526-14A for multimode strands and ANSI/EIA/TIA-526-7 for singlemode strands. Measure the attenuation of the fiber optic network inclusive of all splices and patch points called for on the Drawings.
      iii. Measure attenuation between all the coupling points (when applicable) using the insertion method.
      iv. Perform a reference measurement in dBm to determine the injection power level of the stabilized source. Reference cable shall have the same core diameter as strands under test. Connect the optical source directly to the optical power level meter using 2 reference cables and a coupler.
      v. Connect the optical source to the strand under test using 1 of the 2 reference cables attached to the strand's terminal coupler.
      vi. Connect the optical power level meter to the other end of the strand under test through its terminating coupler using the other reference cable.
      vii. Obtain the measured attenuation (in dB) by subtracting the reference level (dBm) from the received level (dBm).
         (1) Periodically during the acceptance tests, check and document the reference level.
      viii. Test each fiber link for overall attenuation from end to end in both directions.
      ix. Perform the attenuation acceptance test at the 850 nm wavelength for multi-mode and 1310 nm for single-mode.
   b. OTDR Distance and Attenuation Assessments
      i. Perform on all cabling segments 1000 feet or longer.
      ii. Perform in accordance with the requirements of:
         (1) ANSI/EIA/TIA-568-C.1
         (2) ANSI/EIA/TIA-568-C.3
         (3) TIA/EIA-455-59-A
      iii. Test all fibers with launch and far end cable of sufficient length for the OTDR to be able transmit through all installed connectors.
      iv. OTDR through all connectors, a one way test is not acceptable. Means and methods to fully evaluate product installed shall be approved prior to commencing.
      v. Test and submit strip charts and/or tracer recordings on all strands in each tube in every cable in both directions.
      vi. Submit with the following information:
         (1) Date of test
         (2) Name of test personnel

(3) Test wavelength
(4) Pulse duration(s) and scale range(s)
(5) Index of refraction
(6) Fiber cable type and part number
(7) Fiber tube and/or fiber strand number
(8) Direction of test
(9) Overall distance
(10) Attenuation in dB

vii. Localized attenuation shall not exceed 0.5 dB at any point.

G. Test Results Reporting
1. Comply with the detailed reporting results described above and the following:
2. Horizontal Copper Cabling
   a. The Contractor shall test all cables and submit all horizontal copper cable test result data in electronic format, with the resulting file formatted with one test result per 8.5"x 11" page. Export or Download the test results from the cable tester to a *.txt format if a proprietary format has been used in testing cabling.
3. High Pair Count Copper Cables
   a. The Contractor shall test all high count copper cables and submit test result information in an electronic. Acceptable formats are Word, Excel. Owner's Representative to provide required format for test report documentation.
4. Fiber Optic Cables
   a. The Contractor shall test all fiber optic cables and submit all fiber test result data in an electronic format.
   b. Reports shall show Cable number, cursor marks, total attenuation, date of installation and test used.
   c. User Interface records including a graph depicting fiber loss locations and total DB loss per strand via OTDR.
   d. Electronic User Interface Records including a graph depicting fiber loss locations and total DB loss via OTDR.
5. Contractor shall submit (1) copy of software capable of viewing the electronic test result files.

H. Testing Results Review and Verification by the Owner
1. Data found to be altered from the manufacturers recommended settings may result in retention by the Owner of a 3rd party test company to retest the installed cabling at the expense of the Contractor.
2. Data found to be incomplete may result in retention by the Owner of a 3rd party test company to retest the installed cabling at the expense of the Contractor.

PART 2 - PRODUCTS

2.1 Communications Cables and Related

A. General:
1. Cabling shall be UL listed for the application and shall comply with ANSI/TIA-568-C.0, ANSI/TIA-568-C.1, ANSI/TIA-568-C.2, ANSI/TIA-568-C.3 and NFPA 70.

2. Ship cable on reels and/or in boxes bearing manufacture date for UTP in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.
3. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. At plenums, provide type CMP or OFNP cabling.
   b. At risers, provide type CMP or OFNP cabling.
   c. At horizontal wiring, provide type CMP or OFNP cabling.
4. Refer to Section 27 14 00 - Communications Outside Plant Backbone Cabling for underground cabling installation.

2.2 Fiber Optic Communications Cabling and Related

A. General Requirements
1. Fiber count per cable to comply with minimum counts indicated on the plans. Plans indicate specific cable counts providing quantities of multimode and single mode fiber strands.
2. Quantities are minimum quantities. At Contractor's option, provide a greater number. Where a greater number are provided, terminate, test, label and document all strands on fiber patch panels and/or terminal boxes as indicated as if quantity provided were called out for on the plans.
3. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber plenum cable (OFNP), and nonconductive optical fiber riser cable (OFNR) rated cable in accordance with NFPA 70 and UL 910.
   b. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70.
4. Fiber media shall, at minimum, meet the following performance standards:
   a. ANSI/EIA/TIA 568-C.1
   b. ANSI/EIA/TIA 568-C.3
5. Fiber media shall, at minimum, meet the following construction standards:
   a. ICEA S-87-640
   b. ICEA S-83-596
   c. All dielectric, unless otherwise noted.
6. The cable cordage jacket, fiber, unit, and group color shall be in accordance with EIA TIA/EIA-598-B.
   a. Colors shall be across specified storage/installation temperature range.
   b. Means of providing conforming colors shall not degrade performance of cable.
7. Jacket:
   a. Free of splits, holes or blisters.
   b. Armored construction.
   c. Marked and listed in conformance with California Electric Code 770
   d. Conform with
      i. UL 1666 and
      ii. NFPA 70

e. Heavy duty construction, Fiberglass Epoxy Rod/Kevlar strength member(s).
f. Each fiber to be 100% attenuation tested by the Manufacturer prior to shipping. Manufacturer's test to be affixed to shipping reel.
g. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches. Hybrid fiber optic cable marking shall comply with EIA TIA/EIA-598-B.

8. Performance:
   a. Temperature Sensitivity:
      i. Storage: -40C degrees to +70C degrees.
      ii. Installation: -30C degrees to +70C degrees.
   b. Variance:
      i. Multimode:
   c. Specified attenuation is maximum allowed over entire operating range of cable.
      i. Single Mode:
         (1) Average change, not more than 0.05 dB/km at 1550 -40C degrees to +70C degrees.
      ii. Maximum change not more than 0.15 dB/km at 1550 nm.

B. Fiber Strands, Multimode - General
1. Meeting EIA/TIA 568C.3
2. Construction:
   a. Multi-mode
   b. Core Diameter: 62.5 ± 3.0µm
   c. Cladding Diameter: 125 ± 2.0 µm
   d. Numerical Aperture: 0.275 ± 0.015
   e. Core to Cladding Offset: ≤ 3.0 µm.
   f. Coating Diameter: 245 ± 10µm.
   g. Core and Cladding Non-Circularity:
      i. Core: <6.0%
      ii. Cladding <2.0%
   h. Graded Index.
   i. Coating to be mechanically strippable, dual layered, UV-cured acrylate applied by the fiber manufacturer.
   j. OVD Process
3. Each fiber to be 100% proof-tested by the manufacturer to sustain 100 kpsi load minimum.
4. Performance:
   a. Bandwidth:
      i. 850 nm ≥200 MHz at 1 km
      ii. 1300 nm ≥ 800 MHz at 1 km
   b. Chromatic Dispersion:
      i. Minimum Zero Dispersion Wavelength: 1332 nm
      ii. Maximum Zero Dispersion Wavelength: 1354 nm
      iii. Maximum Zero Dispersion Slope: 0.097 ps/nm2·km
   c. Attenuation:
      i. Max attenuation point discontinuity: <0.2 dB at any design wavelength.

ii. Bending Attenuation induced @ 1550 nm, with 100 turns on 75mm dia mandrel: <0.10 dB

d. Attenuation Difference: at 1380 nm,≤ attenuation at 1300 nm + 1 dB/km

e. Water Immersion:

f. Induced attenuation, 23°C water immersion: ≤0.05 dB/km

g. Provides Gigabit Ethernet transmission per the VIP standards for Multi-Mode cable in accordance with IEEE 802.3z.

5. Manufacturer:

a. General Cable 6 Fiber MM - CG0061PNU

b. General Cable 12 Fiber MM - CG0121PNU

c. General Cable 24 Fiber MM - CG0241PNU

d. General Cable 144 Fiber MM – CG1441PNU

e. or approved equal.

C. Fiber Strands, Singlemode – General

1. Meeting EIA/TIA 568C.3 and EIA TIA/EIA-492CAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture.

2. Construction:

a. Single mode fiber strands

b. Mode field diameter:9.3 +/- 0.5µm at 1310 nm (measured per Petermann II)10.5 +/- 1.0µm at 1550 nm

c. Core Diameter: 8.3µm

d. Numerical Aperture: 0.11

e. Cladding Diameter:125 +/- 1.0 µm

f. Coating Diameter: 245 +/- 10 µm

g. Cladding Non-Circularity: ≤1.0%

h. Core to Cladding Offset: ≤ 0.8 µm.

i. Cabled Cutoff Wavelength (l_{ccf}):<1260 nm.

j. Coating to be mechanically strippable, dual layered, UV-cured acrylate applied by the fiber manufacturer.

k. Each fiber to be 100% proof-tested by the manufacturer to sustain 100 kpsi load minimum.

3. Performance:

a. Chromatic Dispersion:

i. Minimum Zero Dispersion Wavelength: 1301.5 nm

ii. Maximum Zero Dispersion Wavelength: 1321.5 nm

iii. Maximum Zero Dispersion Slope: 0.092 ps/nm^2 per km

b. Dispersion:

i. ≤3.2ps/(nm•km) from 1285 nm to 1330 nm

ii. <18 ps/(nm•km) at 1550 nm

iii. Polarization Mode Dispersion:≤ 0.5 ps/ SQRT km

c. Attenuation:

i. Point Discontinuity: ≤ 0.10 dB at 1310 nm or 1550 nm.

ii. Water peak attenuation at 1383 +/- 3 nm :≤ 2.1 dB/km

iii. Bending Attenuation induced @ 1550 nm, with 100 turns on 75mm dia mandrel <0.10 dB

i. Water Immersion: Induced attenuation, 23 degrees C water immersion: ≤0.05 dB/km

d. Manufacturer:
   ii. General Cable
      (1) General Cable 6 Fiber SM - AP0061PNU-ILPA
      (2) General Cable 12 Fiber SM - AP0121PNU-ILPA
      (3) General Cable 24 Fiber SM - AP0241PNU-ILPA
      (4) General Cable 144 Fiber SM – AP1441PNU-ILPA
   iii. Or equal.

PART 2 - EXECUTION
PART 3 - EXECUTION

3.1 General

A. All system cabling and terminations be installed in accordance with the manufacturer's instructions and as shown.

B. All necessary interconnections, services, and adjustments required for a complete and operable system shall be provided. All installation work must be done in accordance with the safety requirements set forth in the general requirements of ANSI C2 and NFPA 70.

C. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.

D. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.

E. Correct unacceptable wiring conditions including but not limited to:
   1. Deformed, brittle or cracked insulation.
   2. Torn or worn cable jacket.
   3. Excessively scored cable jackets.
   4. Insulation shrunken or stripped further than 1/8" away from the actual point of connection within a connector, or on a punch block.
   5. Ungrommeted, unbushed, or uninsulated wire or cable entries.
   6. Deformation or improper radius of wire or cable.

3.2 Splicing

A. All interior wire and outside plant/exterior cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.
   1. At designated splices, maintain conductor color code across all splices.
      e. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels or equipment enclosures.
      f. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards.

B. Backbone Copper Cabling
   1. At interior: Provide splice free cabling between Telecommunications rooms, and from Telecommunications rooms and all locations in the same building indicated for fiber cabling media.
   2. At outside plant: Splice at exterior, unless different splicing is indicated on Plans or is unavoidable due to either cable length exceeding the maximum commercially available in the indicated strand count, or due to on-site pulling conditions. In either condition, provide documentation of the condition to the Owner's Representative for review prior to proceeding. If the Owner's Representative concurs that the conditions warrant the splice:
      g. Splice only within manholes or utility tunnel.
      h. Provide specified multipair splices assembly.
      i. Protect the splice in an encapsulated splice case fastened to a pair of cable rack arms.
      j. Document the installed splice case on the record drawings.
   3. Encapsulated Closures
      k. Adhere to all manufacturer installation guidelines.
      l. Support closure at both ends via racks and steps, so that no unnecessary stress or weight is applied to the splice case or associated conductors.
      m. End Caps and Closure Extension Sleeves
         i. adhere to all manufacturer installation guidelines.
      n. Encapsulants
         ii. Adhere to all manufacturer installation guidelines.
      o. Splicing Tapes
         iii. Adhere to all manufacturer usage guidelines.
      p. Gel Stripper
         iv. Adhere to all manufacturer usage guidelines.

C. Fiber Optic Cabling
   1. At interior: Provide splice free cabling between Telecommunications rooms, and from Telecommunications rooms and all locations in the same building indicated for fiber cabling media.
   2. At outside plant: Do not splice at exterior unless splicing is indicated on Plans or is unavoidable due to either cable length exceeding the maximum commercially available in the indicated strand count, or due to on-site pulling conditions. In either condition, provide documentation of the condition to the Owner's Representative for review prior to proceeding. If the Owner's Representative concurs that the conditions warrant the splice:
   3. Splice only within manholes or utility tunnel.
      q. Provide fusion splices.
      r. Protect the splice in a fiberoptic splice case fastened to a pair of cable rack arms.
      s. Document the installed splice case on the record drawings.
   4. Splicing, where required due to field pulling conditions and/or cable length limits, shall be provided at no additional cost to the Owner.

3.3 Pulling In

A. Verify that all raceway has been de-burred and properly joined, coupled, and terminated

prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.

B. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.

C. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.

D. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.

3.4 Support

A. Secure all wire and cable run vertically for continuous distances greater than thirty (30) feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar devices appropriate to weight of cable. For all other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.

B. Separation. Conform to the following table with respect to separation from power and radio frequency (RF) sources. Provide at least twice the listed separation at fluorescent light fixtures, ballasts and similar high intensity Electromagnetic Field sources, including but not limited to motors, transformers and copiers.

Separation of Telecommunications Cabling and Pathways from 480 V or Lower Power Lines			
Condition	Minimum Separation Distance		
	< 2kVA	2-5 kVA	> 5kVA
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	5 in.	12 in.	24 in.
Unshielded power lines in proximity to a grounded metal conduit pathway.	2.5 in.	6 in.	12 in.
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	N/A	3 in.	6 in.

D. Support: Provide support for all cabling. Conform to the restrictions of the National Electric Code and Section 27 05 29 – Hangers and Supports for Communications Systems.

END OF SECTION

PART 1 - GENERAL

1.1 Scope of Work

A. Section includes provision of lightening protection of all outside plant copper cabling installed under the work of this Project.

B. Related Work Under Other Sections
   1. Related Sections:
      a. Section 27 05 00 – Common Work Results for Communications
      b. Section 27 05 26 – Grounding and Bonding for Communications Systems
      c. Section 27 14 00 – Communications Outside Plant Backbone Cabling

1.2 References

A. Usage: In accordance with Section 01 42 00 – References.

B. In Addition to the requirements of Section 27 05 00 - Common Work Results for Communications and 27 10 00 - Structured Cabling, Basic Materials and Methods, conform to the applicable portions of the following standards agencies:
   1. Underwriters Laboratories, Inc. (UL)
      a. UL 497 (Dec. 15, 1978, 4th Ed.; Rev. thru Jun. 14, 2004) Protectors for Paired Conductor Communication
   2. Code of Federal Regulations (CFR):
      a. 7 CFR 345 Bulletin # 345-65 REA Specification for Shield Bonding (Mar. 1985)
      b. 7 CFR 345 Bulletin # 345-72 Specifications for Filled Splice Closures, PE-74 (Oct. 1985)
      c. 7 CFR 345 Bulletin # 345-83 Specification for Gas Tube Surge Arresters, PE-80 (Oct. 1982)
      d. 7 CFR 1751 Bulletin # 1751F-644 Underground Plant Construction (Aug. 2002)
      e. 7 CFR 1753 Bulletin # 1753F-201 Acceptance Tests and Measurements of Telecommunications Plant (Jun. 1997)
      f. 7 CFR 1753 Bulletin # 1753F-401 Standards for Splicing Copper and Fiber Optic Cable (Feb. 1995)
      g. 7 CFR 1753 Bulletin # 1753F-207 Specifications for Terminating Cables, PE-87 (Jul. 1994)
      h. 7 CFR 1755-4-2004 Telecommunications Standards and Specifications for Materials, Equipment, and Construction.
      i. SUBMITTALS

C. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.3 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 - Product Requirements and Section 27 10 00 – Structured Cabling, Basic Materials and Methods.

1.4 Sequencing

A. Not Used.

1.5 Quality Assurance

A. Unless otherwise noted, protect each pair of each end of each outside plant cable installed under the work of this project.

PART 2 - PRODUCTS

2.1 Wall Mounted Protectors

A. Category 3 Protector Fields & Modules, Stub to Krone
   1. Approvals
      a. UL Listed.
      b. RUS approved.
   2. Features/Functions/Construction.
      a. Accommodates Protector Modules specified herein. Coordinate selected devices to preserve UL Listing.
      b. Wall mount enclosure, with hinged cover
      c. Quiet front - no unprotected parts exposed to end user.
      d. Physical layout compatible with Krone series punch blocks.
      e. Unprotected input: Swivel Cable stub, length to suit application. Terminated in 710 Connector, 3M or approved equal, unless otherwise noted
   3. Protected output: Type 110 block.
      a. Heat Coil Resistance: 4 ohm
      b. Performance:
         i. Voice Pairs:
            1. Gas.
            2. Breakdown Voltage - 265 to 465 V.
            3. Size: 100 Pair, u.o.n.
            4. Protector Quantity:
               a) Unless otherwise noted, protect both ends of each outside plant pair installed.
               b) Provide 98% of protectors as Gas Tube with 4 ohm heat coils
   4. Manufacturer, Protector Field:
      a. Emerson Network Power Electric (formerly Reltec)
      b. 3M.
      c. Circa
      d. Tii Network Technologies, Inc./Porta Systems.
      e. or equal.

B. Manufacturer, Protector Module:
   1. Reliance Comm/Tec, Reliable Electric Division.
   2. 3M.
   3. Circa
   4. Tii Network Technologies, Inc./Porta Systems.

5. or approved equal.

C. Category 6 Lightning Protector
1. Drawing Reference: C6LP
2. Minimum Features, Functions and Performance:
   a. Protected cable meets EIA/TIA Cat 6 performance with C6LP installed in-line.
   b. UL 497, 497A and UL 497B listed for Primary, Secondary, and Isolated Loop Circuit Protection
   c. Ultra low capacitance solid state technology provides protection for frequencies up to 250 MHz
   d. Krone termination
   e. Clamping Voltage: 65 VDC
3. Minimum Environmental Performance Range
   a. Operating Temperature: -13˚F to 149˚F
4. Manufacturers:
   a. Tii Network Technologies, Inc./Porta Systems. Model 606-65.
   b. Emerson Network Power Edco CAT6-5 PoE
   c. Circa
   d. or equal.

PART 3 - EXECUTION

3.1 Surge Protection

A. Unless otherwise noted, all cables and conductors, except un-armored fiber optic cable, which are installed by this project to provide inter-building communication connections, shall have surge protection installed at each end which meets the requirements of REA PE-60.

B. Termination:
1. Provide protection at both ends of all pairs.
2. Provide protector modules equal to the number of installed pairs – refer to the requirements for LP100 in Part 2 of this Section for the types and ratios of protectors to be provided.

C. Locate protection as indicated on the backboard elevations on the plans.
1. If protectors are not indicated on a backboard elevation, located between +24" and 7'-0" above the finished floor at the left edge of the backboard, after allowing for OSP cabling wrapping and management at the backboard edge.

3.2 Protector Tail Cable Management

A. Refer to Section 27 13 00 - Communications Indoor Backbone Cabling for requirements for termination within IDF/HC's, and BDF/EF's.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Communications racks and cabinets.

1.2 RELATED WORK IN OTHER SECTIONS

A. Section 26 05 29 - Hangers and Supports for Electrical Systems

B. Section 27 05 29 – Hangers and Supports for Communications Systems

C. Section 27 05 26 – Grounding and Bonding for Communications Systems
   1. Bonds racks and cabinets.

D. Section 27 05 33 – Conduits and Backboxes for Communications Systems
   1. Signal systems raceways at communications rooms

E. Section 27 05 36 – Cable Trays for Communications Systems
   1. Signal systems cable tray at communications rooms

F. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
   1. Installation of rack mounted power strips, protection and distribution units.

1.3 REFERENCES

A. Usage in accordance with Section 01 42 00 – References

B. American National Standards Institute (ANSI)
   1. EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D)
   2. ANSI/TIA-607-B (2011), Generic Telecommunications Bonding and Grounding (Earthing) and Bonding Requirements for Customer Premises

C. Telecordia Technologies
   1. Network Equipment Building System (NEBS) GR-63-CORE.

1.4 SUBMITTALS

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.5 DELIVERY, STORAGE AND HANDLING

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Keys
1. Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically.

2.2 EQUIPMENT ENCLOSURE SYSTEMS

A. General:
1. Provide enclosure systems including, but not limited to enclosures, cabinets, cases and related panels and accessories as specified herein. Provide size and quantity as shown on drawings or scheduled.
2. Provide color as shown on drawings. If no color is shown on drawings, submit manufacturer's standard color chips for selection.
3. Provide enclosure systems conforming to the CBC, edition as referenced in Section 01 41 00 - Regulatory Requirements, for seismic design using procedures and means of attachment defined in Section 26 05 29 - Hangers and Supports for Electrical Systems.
4. Equipment Enclosures: Each rack provided with frame angles tapped 10-32, ANSI/EIA 310-D Universal Spaced.

B. Relay Rack, Integrated Vertical Wire Chase, Zone 4 rated
1. Drawing Reference: R15
2. Construction
a. Zone 4 listed assembly meets Zone 4 requirements with a least a 500 pound uniformly distributed load.
b. Two wide vertical side channels tapped with EIA mounting holes on both sides, 6" deep section construction minimum.
c. Full 19” wide EIA Frame fits standard equipment forms – assemblies with non-standard opening widths not permitted.
d. Maximum width of relay rack frame (not including vertical wire managers): 25.5 inches.
e. Floor mount plates
f. Top angle or plate.
g. Front and back vertical wire management troughs on both sides of rack, unless otherwise indicated on plans - 6" wide and x 6" minimum depth vertical cross-section, each trough (12” overall depth). Removable horizontal strips or braces at 12" o.c. vertical restrain cabling within trough.
h. 44 EIA Rack Units minimum
3. Manufacturers, Zone 4 rated rack assembly - subject to minimum panel opening criteria scheduled above:
a. B-Line Advantage Seismic Relay Rack SB-852-19-084 FB with SB-571-66D-084 FB double sided deep section wiring manager.
b. Telect/Hendry GS Global Seismic Frame, 19" with Hendry Anchor Kit.
c. Supplement with CPI Double Side Wide Vertical Cabling Sections, CPI

d. 11729-503 or equal.
e. Ortronics Mighty Mo 6 Seismic Cable Management Rack with OR-MM6VML706 Vertical Wire Managers.
f. Chatsworth Products Company Seismic Frame Two-Post Rack with Evolution g2 Double-Sided Vertical Cable Managers, 6” wide with a 10” deep front section to accommodate the flange thickness of CPI seismic rack frame.
g. Or equal.

C. Equipment Rack, Zone 4, Front, Rear and Side Access, with Vertical Wire Management.
1. Drawing References: R27
2. Minimum Features, Function & Construction:
a. Manufacturer tested Zone 4 assembly, rated for at least 900 pounds of uniformly distributed load, upper floor load, of essential equipment per California Building Code/Uniform Building Code.
b. Fully welded construction provides:
i. Static load capacity: 10,000 lbs.
ii. UL Listed load capacity: 2,500lbs.
iii. Seismic Certified load capacity: 755 lbs.
c. Seismic certified to the following codes and standards: 2007 & 2010 CBC; 2006, 2009 & 2012 IBC; ASCE 7-05 (2005 Edition) & ASCE 7-10 (2010 Edition) and the 2006 & 2009 editions of NFPA 5000 for use in areas of high seismicity – Zone 4 or Seismic Design Category (SDC) "D". Intended for use in Mission Critical and/or High-Importance Installations in locations with the highest level of seismicity and top floor or rooftop installations including those within UBC and CBC Essential facilities or IBC, ASCE 7, and NFPA 5000 Seismic Use Group III facilities. For all codes, the Importance factor (Ip) is 1.5.
d. Vertical Height (Min): 44 RU
e. Outside depth: 34 inches minimum - 36 inches maximum.
f. Width: Not to exceed 30 inches
g. Lockable, 70% open area perforated mesh full height front and rear doors:
i. Front door with wire mesh insert covers rack contents - swing shall be field adjustable to swing from either right or left.
ii. Rear doors to be a pair of half width doors, each with a wire mesh to cover rack contents.
iii. Wire mesh, vertical center split rear door pair.
h. Front and rear 19" mounting rail pairs DIN square holes on EIA spacing standard are fully adjustable in depth of setback from front to rear.
i. Vertical cable management rings, continuous, full height cable management system shall be installed:
i. fully inside of the rack enclosure, with 2" minimum clearance behind front and rear rack frame.
ii. fully outside (to left of left rail and to right of right rail, and out of conflict with EIA Rails. Cable management system mounting shall not occupy rail screw openings.

iii. Front managers shall be accessible from front in fully loaded equipment rack.
iv. Rear managers shall be accessible from rear in fully loaded equipment rack

j. 60% or greater perforated top panel occupying at least 50% of the stop surface of the cabinet allows passive heat radiation from rack interior to the exterior.
k. Cutouts and removable covers in cabinet top accommodates vertical transition of cabling from tray above into rack interior.
l. Gangable. Racks have been designed such that they are suitable for installation either as a single, standalone unit, or in a row of identical racks (gangable).
i. Single rack installation. Provide side panels at both sides.
ii. Multirack installation in a row. Bolt racks together using means provided by manufacturer. Omit side panels except at ends of row of racks – provide at ends of rows of racks.

3. Manufacturers. Provide manufacturer's accessories or 3rd party accessories as specified elsewhere in this Section for other specified elements. Coordinate selected shelves, fans and similar with rack submitted for finish and mounting means.:
a. Middle Atlantic DRK19-44-36PRO with DLVFD-44 front door, DCLVRD-44 rear doors, MRK-Z4 Base angles, 2 pair DRK-44DUCT (front and rear, 4 total vertical ducts),MW-LVT 64% open area top insert. Keylocked side panels SPN-44-36 at ends of rows.
b. APC Infrastructure
c. Hoffmann
d. Liebert/Knurr
e. Wrightline Paramount, Vantage or Vantage 2.
f. or equal.

D. Seismic AV Equipment Rack, Front, Rear and Side Access.
1. Drawing Reference: R33
2. Construction:
a. Manufacturer tested Zone 4 assembly, rated for at least 900 pounds of uniformly distributed load under Zone 4 forces.
b. Vertical Height (Min): 44 RU
c. Overall Depth: 27" minimum.
d. Overall Width: Nominally 24"
e. No Front Door
f. Lockable wire mesh rear door.
g. Fully Adjustable 19" Mounting Rails, 10-32 threaded openings on EIA spacing standard
h. Full height receptacle strip, at least one (1) circuit, 20A, unless otherwise noted, as specified elsewhere in Section 27 11 26 - Communications Rack Mounted Power Protection and Power Strips.
i. Provide each rack with the following accessory shelves:
j. One (1) Exhaust Fan Panel, at top or rear doors, at least 200 CFM.

k. Gangable. Racks have been designed such that they are suitable for installation either as a single, standalone unit, or in a row of identical racks (gangable).
l. Single rack installation. Provide side panels at both sides.
m. Multirack installation in a row. Bolt racks together using means provided by manufacturer. Omit side panels except at ends of row of racks – provide at ends of rows of racks

3. Manufacturers. Provide manufacturer's accessories or 3rd party accessories as specified elsewhere in this Section for other specified elements. Coordinate selected shelves, fans and similar with rack submitted for finish and mounting means.:
   a. Middle Atlantic WRK-44-27LRD, MW-LVRD-44 rear door, WRK-Z4 Mounting Brackets, MW-4FT top w/ 4 fans.
   b. APC
   c. AFCO
   d. Hoffmann
   e. Lowell
   f. Wrightline
   g. or equal.

2.3 RACK PANELS AND ACCESSORIES

A. Rack Mounting Screws:
   1. Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.

B. Sliding Shelf:
   1. Plan Reference: SLIDING SHELF
   2. Construction/Features:
      a. 16 gauge minimum cold rolled steel
      b. Powder coat finish to match rack color, unless otherwise noted
      c. 19" Wide Pull out with handhole or knob.
      d. Solid or perforated surface
      e. Depth: At least 20", u.o.n.
      f. 50 pound minimum load capacity
   3. Manufacturers:
      a. Atlas Sound
      b. BGW Systems, Inc. Sliding Shelves
      c. Chatsworth Products 32" Deep Megaframe Sliding Shelf.
      d. Elkay SLSH series
      e. Homaco Adjustable Pull-Out Equipment Shelves
      f. Hubbell MCCTELSHLF
      g. Middle Atlantic Heavy-Duty Sliding Shelf
      h. APW SSDC30.
      i. AFCO AS-SO-19-24.
      j. Or equal.

C. Fixed Shelf - 4 post rack applications

1. Plan Reference(s):
   a. FIXED SHELF
   b. SHELF
2. Construction:
   a. 16 gauge minimum cold rolled steel
   b. Powder coat finish to match rack color, unless otherwise noted
   c. Holds 100 lbs load
   d. Mounts to front and rear rails, U.O.N.
   e. Solid or Perforated bottom panel to suit equipment being mounted.
   f. Depth to equal not less than 75% of depth of equipment rack.
   g. Not more than 1 RU in height.
3. Manufacturers:
   a. Atlas Sound Heavy Duty Shelves, SH series.
   b. BGW Systems, Inc. Rack Mount Trays
   c. Elkay SSH Series
   d. Homaco Adjustable Equipment Shelves and Fixed Dual Shelves
   e. Lowell Rack Mounted Utility Shelves
   f. Middle Atlantic Universal Rackshelves
   g. Rack Innovations, Inc.
   h. ZERO/Stantron Stationary Shelves
   i. AFCO AS-SF-19-24
   j. APW ESDC30.
   k. Hubbell MCCPSHLF
   l. Chatsworth Products 29" Deep Megaframe Fixed Shelves.
   m. or equal

D. Fixed Shelf - 2 post rack applications
1. Plan Reference(s):
   a. FIXED SHELF
   b. SHELF
2. Construction:
   a. 18 gauge minimum cold rolled steel
   b. Powder coat finish to match rack color, unless otherwise noted
   c. Holds 25 lbs load
   d. Mounts to front rails, supports load to rear of frame. U.O.N., center support shelves not acceptable.
   e. Solid or Perforated bottom panel to suit equipment being mounted.
   f. Not more than 1 RU in height.
3. Manufacturers:
   a. Chatsworth Products, Inc.
   b. or equal

E. Keyboard/Mouse Shelf
1. Drawing Reference: Keyboard/Mouse Shelf
2. Stores fullsize keyboard and mouse inside rack.
3. Upon retraction to rack front, pivots 90 degrees for operator access.
4. Manufacturers
   a. APC 19" Rotating Keyboard Drawer.

b. Middle Atlantic
c. or equal.

F. Grommet Panel
1. Features/Functions/Construction
a. 1 RU steel or aluminum panel with 18" wide x 1" tall smooth edged
b. opening in face
c. Cable management panel protrudes below opening perpendicular to rear face.
2. Manufacturers:
a. Middle Atlantic BR1
b. Custom by Contractor using Blank Panel
c. or equal.

G. Blank Panels:
1. Construction
a. 16 gauge minimum cold rolled steel
b. Powder coat finish to match rack color, unless otherwise noted
2. Manufacturers
a. Middle Atlantic Products SB Series.
b. Atlas Sound S19 Series.
c. BGW Systems Inc. Flanged Steel Blank Panels
d. Dukane
e. Elkay
f. Lowell Series L3
g. Zero ZP112000 Series.
h. Hubbell
i. or equal.

H. Vent Panels:
1. Construction
a. 20 gauge minimum cold rolled steel
b. 1/8" minimum holes, at least 70% open total panel cross-section.
c. Powder coat finish to match rack color, unless otherwise noted
2. Manufacturers
a. Atlas Sound SVP Series.
b. BGW Systems Inc. Perforated Vent Panels
c. House of Metal Enclosures (HOME) Series PRP.
d. Lowell Series L5
e. Middle Atlantic Products VT Series.
f. Zero.
g. or equal.

I. Drawers
1. Construction
a. 16 gauge minimum cold rolled steel
b. Powder coat finish to match rack color, unless otherwise noted
c. Suitable for mounting from face of 4 post rack
d. At least 14-1/2" deep.
e. Full extension ball bearing slides with trigger release disconnect.

f. Rated for at least 100 pound load.
g. Flush handle does not protrude from drawer face.
h. Provide key lock where indicated.

2. Manufacturers
   a. BGW Systems Inc. Rack Mount Drawer Systems.
   b. Middle Atlantic Heavy Duty D or TD series.
   c. Atlas Sound SD*-165FP Series.
   d. Elkay SSD Series.
   e. or equal.

J. Vertical Lacer Strips
1. 44RU high vertical steel strips with points for attachment of velco cable ties at at least 6” o.c.
2. Manufacturers:
   a. Middle Atlantic LACE-44LP
   b. APW
   c. or equal.

K. Horizontal Lacer Bars
1. EIA 19” Width steel strips or bars suitable to provide support to large cable dressed horizontally through racks
2. Size to suit load and mounting width.
3. Manufacturers:
   a. Middle Atlantic LBP-1R4, LBP-1.5 and LBP-1S.
   b. APW
   c. or equal.

L. Seismic Hold-down Equipment Straps
1. Drawing Reference: None - Provide as required to secure equipment that can not be screw fastened to mounting shelves.
2. Manufacturers:
   a. BGW Systems
   b. Everest Electronic Equipment Lock Down Kit
   c. Ergotron
   d. Chatsworth Products
   e. Middle Atlantic Products
   f. Q-Safety, Inc.
   g. or equal.

PART 3 - EXECUTION

3.1 MOUNTING

A. Unless otherwise noted, all floor supported equipment racks shall be bolted to the structure in accordance with the requirements of the CBC and the contractor’s approved structural engineering submittal demonstrating the method to be used to conform to these requirements.
B. Rows of identical racks shall be bolted together with rack managers between, in addition to being bolted to the floor, and individual bond cables to form a single electrical ground plane

C. Wall mounted equipment racks and cabinets shall similarly be bolted to structural members in accordance with the requirements of the CBC and the contractor's approved structural engineering submittal demonstrating the method to be used to conform to these requirements.

3.2 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.

B. Provide permanent labels for all equipment and devices.

C. Floor racks to be bolted floor unless otherwise indicated.

D. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.

E. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.

F. Where wiring of mixed types are called for on the plans, maintain separation of wiring classifications as specified in the individual sections of the Communications Work. Separately dress, route and land microphone, audio line level and data cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level, data and control cables on the left side of the equipment enclosure, as viewed from the rear.

G. Provide vertical wire management of cabling within the rack independent of the adjustable EIA mounting rails. Vertical wiring management provided by the contractor within the rack shall not prevent such rails from being moved as required by the Owner.

H. Dress and support cabling at a minimum of 24 inch on center.

I. Access shall not require demounting or de-energizing of equipment or cabling. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.

J. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.

K. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.

L. At audio and video jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible without cutting apart the harness.

M. Coordinate the design and execution of wire harnessing of multi-bay audio and video rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.

3.3 SIGNAL GROUNDING & BONDING PROCEDURES

A. Comply with National Electrical Code and the California Electric Code. Bond equipment racks to ground in accordance with the California Electric Code and ANSI/ EIA/ TIA 607 and Section 27 05 26 – Grounding and Bonding for Communications Systems.

B. Maintain a unipoint ground scheme – bond each rack individually to the TMGB, do not bus grounds.

C. Equipment enclosures shall not be permitted to touch each other unless bolted together and electrically bonded.

END OF SECTION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section defines material standards for:
   1. Copper Termination Assemblies, including
      a. Rack and cabinet mounted copper patch panels
      b. Rack and cabinet mounted network switch distribution patch panels
      c. Backboard, rack and cabinet mounted terminal blocks
   2. Fiber Termination Assemblies, including:
      a. Fiber connectors
      b. Rack and cabinet mounted fiber patch panels
      c. Backboard mounted fiber terminal boxes
   3. Hybrid Copper/Fiber Termination Assemblies.

1.2 Related Work under other Sections

A. Section 27 05 00 – Common Work Results for Communications
B. Section 27 05 53 – Identification for Communications Systems
C. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
D. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
E. Section 27 11 23 – Communications Cable Management
F. Section 27 13 00 – Communications Interior Backbone Cabling
G. Section 27 14 00 – Communications Outside Plant Backbone Cabling
H. Section 27 15 00 – Communications Horizontal Cabling

1.3 References

A. Usage: In accordance with Section 01 42 00 – References.
   1. ELECTRONIC INDUSTRIES ALLIANCE (EIA)
      a. EIA-310-D (1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D)

1.4 Submittals

A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.5 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 - Product Requirements and Section 27 10 00 – Structured Cabling, Basic Materials and Methods.

1.6 Sequencing

A. Not Used.

PART 2 - PRODUCTS

2.1 Copper Cable Termination Devices and Related

A. Category 5e Terminal Block.
1. Drawing reference(s):
   a. 110TB6 6 pair
   b. 110TB25 25 pair
   c. 110TB50 50 pair
   d. 110TB100 100 pair
   e. 110TB300 300 pair
   f. 110TB600 600 pair
2. General: Insulation displacements connector blocks consisting of oxygen free mechanical fastening system arranged in a flame-retardant molded plastic fastened to a mounting bracket.
3. Features/Functions
   a. “110 type” punch down type.
   b. Cable routing space behind the blocks.
4. Conforms with REA PE-87.
5. Performance:
   a. Complies with Commscope/Systimax 110 Premises Distribution System Specifications
   b. Electrical (measured at 50 MHz).
   c. Resistance: Not more than .4 ohms/termination
   d. Inductance: Not more than 13 nH/termination
   e. Capacitance:
      i. Not more than .9 pF/termination, same pair.
      ii. Not more than .7 pF/termination, next pair.
6. Construction/Implementation
   a. Provide complete with standoff mounting brackets
   b. Provide trough at the bottom of each column of blocks.
   c. Unless otherwise noted, provide WMP between each column of blocks, and at the outside edges of each group of block columns.
7. Manufacturer:
   a. Siemon S110 or S110M Modular Tower System
      i. S110M42-300FT300 Pair
      ii. S110M42-400FT400 Pair
      iii. S110M42-500FT500 Pair
      iv. S188WDTrough
   b. Ortronics.
      i. 110-PB2-300FT300 Pair
      ii. 110-PB2-900FT900 Pair
   c. Hubbell Wall Mount Kits, 110
   d. AMP CrossConnect Distribution Frame Kit 56985* Series
   e. Leviton
   f. Commscope/Systimax
   g. Commscope/Uniprise
   h. Wiremold.
   i. Panduit.

j. or equal.

B. Data Patch Panels, Keystone, Rack Mounted
1. Drawing Reference:***CXPPK, or CXPP, where *** refers to port count and X to Category rating of ports.
2. Functions/Features:
   a. 19" EIA rack mountable.
   b. At least 24 ports per EIA rack unit (1.75").
   c. Industry standard keystone openings in steel plate
   d. arranged in rows on steel panel,
   e. jacks on front,
   f. terminations on rear.
   g. Port identifier label space on front.
   h. Fill each opening with Category 6 keystone jacks as specified herein above. Coordinate jack selection with patch panel construction to ensure that jack width behind the panel does not prevent fully loading panel.
   i. Integral cable management bar at rear.
3. Manufacturer
   a. Leviton QuickPort High Density Multimedia Patch Panels with Management Bar
   b. Panduit Netkey
   c. Hubbell Xcelerator Series Panels
   d. Molex EZ Patch
   e. Suttle SE-2504 and SE-2504-48 Patch Panels
   f. AMP
   g. ADC/Krone
   h. Ortronics
   i. or equal.

C. Category 3 Rack Mount Patch Panels with Pre-Wired RJ-21C (50 Pin) connector, 8P4C
1. Drawing reference:
   a. **PWC3PP, where ** designates port count.
2. Features/Functions/Construction:
   a. 19" EIA rack mount panel.
   b. Front face - RJ45
3. Rear Face – Two pre-wired RJ21C connector (50 Pin).
4. Printed Circuit board linking RJ45's to two RJ21C (Amphenol Connectors) to center 2 pairs (pins 3-6) on RJ45's.
5. Approvals
   a. ANSI/TIA-568-C.2 for Category 3 performance
   b. ANSI/TIA-1096A (formerly FCC Part 68)
   c. Nationally recognized test laboratory (NRTL) listed
6. At least 24 Jacks per rack unit (RU).
7. Manufacturers:
   a. Leviton 49014-J24
   b. Hubbell
   c. Amp
   d. Panduit

e. or equal

2.2 FIBER CABLE TERMINATION DEVICES AND RELATED:

A. Fiber Optic Connectors and Related:
1. General
a. Connectors to comply with:
i. EIA/TIA-4750000-C
ii. EIA/TIA-604-3A
2. Fusion Splice System
a. Insertion Loss:
i. ≤0.03 dB - manufacturer's rating for typical splice – multimode
ii. ≤0.06 dB - manufacturer's rating for typical splice – singlemode.
b. Manufacturer
i. Corning Cable Systems Model X77 Micro Fusion Splicer
ii. AFL Telecommunications.
iii. or equal.
3. Connectors:
a. LC with manufacturer installed fiber pigtails unless otherwise noted or scheduled. Contractor to fusion splice the supplied pigtail to the fiber backbone cabling installed under the work of this Project.
b. Connector performance per TIA- 568.C.3 and the following.
i. Insertion Loss:
(1) Multimode:
(a) Less than or equal to 0.75 dB per mated pair
(2) Singlemode, Ultra Polish
(a) Less than or equal to 0.75 dB per mated pair
(3) Singlemode, Angle Polish
(a) Less than or equal to 0.30 dB per mated pair
ii. Return Loss
(1) Singlemode, Ultra Polish, greater than or equal to 55 dB
(2) Singlemode, Angle Polish, greater than or equal to 65 dB
iii. Manufacturer, Connector
(1) Corning Cable Systems
(2) AMP
(3) Commscope/Systimax
(4) Hubbell
(5) Leviton
(6) Ortronics
(7) or equal.

B. Fiber Distribution Panels, Splice and Patch.
1. Drawing References:

a. *** FPP, Fiber Patch Panel where *** refers to the fiber port count.

2. Features/Functions/Performance:
   a. 19" EIA rack mount.
   b. Suitable for housing fiber optic mechanical splices in a neat and orderly fashion.
   c. Stores a minimum of one meter of cable without kinks or twists.
   d. Suitable for use with connectors with manufacturer supplied fiber pigtails as required herein above, fusion spliced to building and outside plant backbone cabling.
   e. Provides individual strain relief for each splice.
   f. Suitable for reentry, if required for future maintenance or modification, without damage to the cable or splices
   g. All required splice organizer hardware, such as splice trays, protective glass shelves, and shield bond connectors shall be provided.
   h. Incorporates cable tie downs and routing rings.
   i. Quick-Release Hinges — Spring loaded quick release hinges enable easy removal of front and rear doors for complete access to fiber connections
   j. Enhanced Labeling — Label virtually any port configuration hinged labels. The labels hang on the front door for improved visibility. When the door is opened, labels flip down allowing ready viewing of the label and corresponding ports.
   k. Rotating Grommets — Rotating grommets facilitate loading and retention of jumpers and fiber while minimizing microbending stress when using the sliding tray.
   l. Complete Access — Management tray has a positive stop in both front and rear working positions providing complete access for moving, adding, changing, or cleaning of fiber connections
   m. Maximum Capacity — Enables a maximum amount of fibers to be patched or patched and spliced in a 2, 3, and 4 RMS enclosure without compromising the accessibility. This allows more efficient utilization of rack space.
   n. Top and bottom access holes located at the rear of the enclosure allow fibers to be routed between tandem enclosures without having to run fibers outside of the enclosure.
   o. Color coded front panel patch connector - color yellow at singlemode strands and color blue at multimode strands. Provide manufacturer’s blank cover inserts at unused openings.
   p. High Density - FPP can terminate between 18 to 36 strands per rack unit. Higher density assemblies not acceptable unless otherwise indicated on the plans.
3. Manufacturer:
   a. Corning Cable Systems Pretium Connector Housing (PCH) with splice trays, strain relief and Closet Connector Housing (CCH) inserts as required.
   b. Hubbell OptiChannel FCR Rack Mount Enclosures with FSP Adapter Panels as required.
   c. Leviton
   d. Panduit

e. Ortronics
f. Commscope/Systimax
g. or equal.

PART 3 - EXECUTION

3.1 General

A. Refer to Section 27 13 00 - Communications Indoor Backbone Cabling for requirements for termination of Riser and Outside Plant Cabling within IDF/HC's, and BDF/EF's .
B. Refer to Section 27 10 00 – Structured Cabling, Basic Materials and Methods and Section 27 15 00 – Communications Horizontal Cabling.

END OF SECTION

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PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Section includes provision of cable management for cabling installed under the work of this Project as well as for Owner furnished patch cords at equipment racks
B. Scope includes:
   1. Innerduct
   2. Interior
   3. Outside Plant
   4. Cable End Spillway
C. Backboard Cable Management
D. Patch Panel Cable Management at racks and cabinets

1.2 Related Work in other Sections

1. Section 27 05 33 – Conduits and Backboxes for Communications Systems
2. Section 27 05 36 – Cable Trays for Communications Systems
3. Section 27 05 39 – Surface Raceways for Communications Systems
4. Section 27 05 43 – Underground Ducts and Raceways for Communications Systems
5. Section 27 05 53 – Identification for Communications Systems
6. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures

1.3 References

A. American Society For Testing and Materials (ASTM)
   1. ASTM D2239-03 Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
B. Underwriters Laboratories (UL)
   1. UL 910 Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables used in Spaces Transporting Environmental Air (Nov. 1998)

1.4 Submittals

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.5 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 Innerduct

A. Innerduct, Single Chamber
1. Drawing and spec reference(s):
a. ID*, Innerduct ("*" denotes cross sectional area of innerduct referenced to standard conduit trade size).
b. IDP*, Innerduct, Plenum ("*" denotes cross sectional area of innerduct referenced to standard conduit trade size).
2. Construction:
a. Selected product suitable for:
i. underground installation in ductbank,
ii. plenum (IDP)
iii. exposed, in interior utility rooms where indicated.
b. High density polyethylene.
c. Ribbed or similar exterior construction to resist crushing surface to promote fiber cable installation.
d. Provides an interior chamber with a capacity equal to a trade size conduit referenced above.
3. Approvals:
a. ASTM D2239(1985) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
b. IDP - UL Standard Test Method 2024 of UL 910.
4. Manufacturers, ID in underground ductbanks:
a. Carlon Optic-Gard/PE.
b. Arnco.
c. Vikimatic.
d. or equal.
5. Manufacturers, ID in interior, non-plenum applications:
a. Carlon Optic-Gard/PVC.
b. Arnco.
c. Vikimatic.
d. or equal.
6. Manufacturers, IDP:
a. Carlon Plenum-Gard.
b. Arnco.
c. Vikimatic.
d. or equal.

B. Innerduct, UV Rated
1. Drawing Reference: ID, UV Rated*, where"*" denotes cross sectional area of each chamber referenced to standard conduit trade size).
2. Approvals:
a. ASTM D2239(1985) Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
3. Construction.
a. Listed for UV exposure.
4. Manufacturers:
a. Tamaqua Plus II Series Telecom Duct.
b. Allwire Black AllDuct.

c. or equal.

C. Woven Mesh Innerduct
1. Drawing Reference: MID, WMID
2. Features/Functions
a. Three inch wide woven mesh assembly contains at least three continuous pullable sleeves, each can accommodate a cable of at least 1” diameter.
b. Systems providing fewer than 3 integrally woven sleeves per WMID assembly not acceptable.
c. Includes color coded pull tape in each sleeve.
d. Pre-Lubricated for cable pulling
e. Non-Hydroscopic
f. 2500 Pound Tensile Strength
g. 480 degree F melting point.
h. At least 5 years prior field use including at least 25 million feet of product in use.
i. Provide plenum rated assembly at plenum locations as defined by the California Electric Code.
3. Manufacturers:
a. Maxcell/TVC 3” 3-cell in three unique colors per duct.
b. or equal (No known equal with identical 3 sleeves woven into a single assembly nor equal industry usage).

2.2 Conduit Cable Management

A. Conduit End Waterfall Spillway
1. Drawing Reference: CEW
2. Features/Functions
a. Spillway fastens to end of EMT conduit, provides radius sweep, open on top, solid from below
b. Maintains proper bend radii for fiber/cable
c. Provides tie points for fire pillow retention
d. Supports up to 100 lbs. of hanging fiber/cable
e. Clamp for securing to EMT
f. Self-fastening tie down system for supporting cabling
3. Construction:
a. Fire Retardant ABS
4. Manufacturers:
a. Bejed BJ-2049 Spillway.
b. or equal (no known equal).

2.3 Ladder Rack Cable Management

A. Waterfall Accessories – At all Cable entry and exit points to the Ladder Rack
1. Cable Management Waterfall to maintain bend radius in both vertical and horizontal directions
a. Panduit CMW Series
b. or equal

2.4 Patch Panel Cable Management

A. Patch Panel Wire Management, Rack Mounted, Snap Cover.
1. Drawing References:
   a. 1 RU Version: RMWM1C
   b. 2 RU Version: RMWM2C
2. Construction
3. EIA 19 or 23" Rack Mount, as required
4. Continuous flexible system of fingers and slots along top and panel, deburred to avoid snagging patch cord jacket.
5. Snap Cover
6. Provide 4 RU assembly at the center of each rack, except as described for Network Switch Rack at the top of each Network Switch
7. Manufacturers – 2 RU:
   a. Panduit NM2.
   b. or equal.
8. Manufacturers – 1 RU
   a. Panduit NM1.
   b. or equal.
9. Manufacturers – 4 RU:
   a. Panduit NMF4.
   b. or equal

B. Network Switch Rack Switch Patch Panel Wire Management
1. Construction
   a. EIA 19 Rack Mount
   b. Continuous flexible system of fingers and slots along top and bottom of patch panel, deburred to avoid snagging patch cord jacket.
   c. Provide 4 RU assembly at the top of each switch frame rack as described in Section 16765 - Communications Termination Blocks and Patch Panels.
2. Manufacturers
   a. Panduit NCMHAEF4.
   b. or equal

2.5 Backboard Cable Management

A. Fiber Management Ring, Preformed Loop
1. Drawing Reference: FMR
2. Construction:
   a. 24 inch diameter steel ring stores fiber slack using Velco fasteners at regular intervals around ring.
   b. Screw fastens to backboard at BDF or IDF.
3. Manufacturer
   a. Leviton 48900-OFR
   b. or equal (no known equal)

B. Wire Management Rings, Wall/Ceiling Mounted:
1. Drawing References/Functions Features:
   a. WMRB - Bridle Ring Type, Threaded Lag Screw

b. WMRC - Closed Ring, U shaped assembly with two screw holes at ends,
c. WMRO - Open, Re-enterable Split Ring permitting cables to be inserted midspan, two screw holes at ends
d. WMP** - Steel back board with 4 inch deep min, 8 inch wide vertical wire management rings, front enterable. Provide trough at bottom of each column of WMP.
e. WMP**T - Narrow, steel back board with 4 inch deep min, 3 inch wide vertical wire management rings, front enterable.

2. Provide as required to support indicated cable bundle and location.
3. Provide type WMRB at wood frame construction for cable hung from underside of ceiling, unless otherwise noted.
4. Manufacturers:
   a. WMRB:
      i. B-Line Fasteners, BR Series
      ii. Senior Industries
      iii. T&B
      iv. or equal.
   b. WMRC
      i. Chatworth Products Wall Mount Closed D Ring.
      ii. Senior Industries
      iii. or equal.
   c. WMRO
      i. Chatworth Products Wall Mount Open Ring.
      ii. AllenTel
      iii. Commscope/Systimax, Inc.
      iv. Siemon
      v. or equal.
   d. WMP
      i. Siemon S188-*** to match adjacent terminal blocks with S188-WD
      ii. Ortronics OR-806003194 or OR-806003196 to match terminal blocks.
      iii. or equal.
5. WMP**T
   a. Siemon S110M-WM-*** to match adjacent terminal blocks
   b. Otronics
   c. or equal.

PART 3 - EXECUTION

3.1 Innerduct Installation

A. Schedule of Application
1. Underground
   a. At 3” ducts and inside maintenance holes and vaults, place fiber cabling and 50 pair and smaller copper telephone cabling inside WMID.
   b. Omit WMID at conduits smaller than 3” diameter.
2. Interior

a. At 3” and larger interior conduits, provide WMID. Provide plenum rated WMID at plenum ceiling conditions. Place fiber cabling and 50 pair and smaller copper telephone cabling indicated for placement in Raceway inside WMID.

3.2 Conduit End Waterfall

A. Fasten securely to conduit end wherever cabling will exit conduit 18" or more above the cable tray to prevent damage due to cabling due to weight of cable bearing on a conduit end.
B. Secure cabling with integral cable restraint system.

END OF SECTION

PART 1 - GENERAL

1.01 Scope of Work

A. Section includes provision of:
1. Vertical power strips at racks and cabinets installed under the work of this Project.

1.02 Related work in other sections

A. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures

1.03 References

A. Electronic Industries Alliance (EIA)
1. EIA-310-D(1992) Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D).

1.04 Submittals

A. Conform with the requirements of Section 01 33 23 – Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.05 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 – Product Requirements.

1.06 Sequencing

A. Not Used

PART 2 - PRODUCTS

2.01 Equipment Enclosure Power, Protection and Signal Grounding

A. Comply with applicable Codes. Provide UL Listed devices suitable for commercial use. Provide all junction boxes, raceway, fittings, wire, supports and fastenings as required for complete installation. Unless otherwise noted, provide receptacles of NEMA 5-15R configuration.
B. Full Height Receptacle Strip, One (1) Circuit, 15A
1. Features/Construction:
a. Not less than 60" Long
b. Not less than eleven (11) 15A receptacles
c. Integral circuit breaker
d. NEMA 5-15P plug on 6' cord.
e. UL Listed Assembly
f. Provide mounting hardware as necessary to attach to rack interior.
2. Manufacturers.
a. Wiremold Series 7011ULBC.

b. Lowell ACS 1524
c. Geist NSVB200-101S15
d. Hubbell PR206
e. Leviton
f. Middle Atlantic
g. Chatsworth 12848-701
h. or equal.

C. Full Height Receptacle Strip, One (1) Circuit, 20A
1. Features/Construction:
a. Not less than 70" Long
b. Not less than eleven (11) 15A receptacles
c. Integral circuit breaker
d. NEMA 5-20P plug on 6' cord.
e. UL Listed Assembly
f. Provide mounting hardware as necessary to attach to rack interior.
2. Manufacturers. Contractor to coordinate selected strip with rack power receptacles installed under the work of Division 26.
a. Geist NSVB200-102S20
b. Hubbell PR20820DRTL
c. Leviton P104x series
d. Lowell ACS-2024
e. Midde Atlantic PD-1020C-NS
f. Wiremold Series 7011ULBC20.
g. Chatsworth 12848-705
h. or equal.

D. Rackmount Power Panel, Horizontal Mount, User Aux device use:
1. Drawing Reference: POWER.
2. Functions/Features:
a. Front face of panel shall provide two electrical power outlets and a switch. An indicator lamp shall show the presence of AC power when on. The front face of panel shall have a black finish. The rear face shall provide a minimum of at least four receptacles. The panel shall be racked mounted in a maximum of two rack units. The panel shall be Code approved and UL rated for this application.
3. Manufacturers:
a. Hubbell MCCPSS19TS
b. Leviton 4515
c. Geist SP124-1020
d. or equal.

PART 3 - EXECUTION

3.01 General

A. Conform with the requirements of Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures and the following:
B. Communications Rack Power Strips. Confirm the location of Power Strips with the Owner's Representative. (1) One Power Strip per Vertical Wire Manager is required.

C. Power Strip Mounting:
   1. Mechanically fasten strips to the rack/cabinet being served using strip or rack being served
   2. Mount strip so that it does not impede user access to:
      a. Vertical wire management integral to the racks
      b. Front and rear movement of adjustable EIA mounting rails supplied with the rack or cabinet.
      c. Mounting of Owner furnished EIA rack mountable equipment within the served rack.
   3. Unless otherwise noted, the strip to be mounted to derive power from electrical receptacles mounted to the cable tray above the rack. Mount strip so that the power cord reaches the provided receptacles without:
      a. causing tension on the power cord,
      b. putting it in direct contact with signal cabling
      c. putting it in contact with sharp edges
      d. lacing it to parts intended to be movable, including, but not limited to:
         i. slide out drawers and shelving
         ii. rack mounted for Owner furnished servers on pullout rails
         iii. EIA adjustable mounting rails.

END OF SECTION

PART 1 - GENERAL

1.1 Scope of Work

A. Work of this Section includes:
1. Outdoor (Outside Plant) Communications Cabling placed underground in existing communications ducts, including:
a. High pair count copper cabling
b. Fiber Optic Cabling
2. Work of this project extends (e) OSP fiber cabling from Police Headquarter stubbed into lower level, terminates on fiber patch panel, tests and labels.
3. Terminate fiber on patch panels as specified in Section 27 11 19.
4. Terminate copper cabling on lightning protectors as specified in Section 27 11 13.
5. For all cabling:
a. Test cabling to demonstrate performance to specified standards or better using test equipment and methods as specified in Section 27 10 00.
b. Label cables, jacks, plates and patch panels as specified in Section 27 05 53.
c. Document on Record Documents as described in Section 27 05 00.

B. Related work in other Sections
1. Section 27 05 00 – Common Work Results for Communications
2. Section 27 05 26 – Grounding and Bonding for Communications Systems
3. Section 27 05 29 – Hangers and Supports for Communications Systems
4. Section 27 05 33 – Conduits and Backboxes for Communications Systems
5. Section 27 05 36 – Cable Trays for Communications Systems
6. Section 27 05 43 – Underground Ducts and Raceways for Communications Systems
7. Section 27 05 48 – Noise and Vibration Controls for Communications Systems
8. Section 27 05 53 – Identification for Communications Systems
9. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
10. Section 27 11 13 – Communications Entrance Protection
11. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
12. Section 27 11 19 – Communications Termination Blocks and Patch Panels
13. Section 27 11 23 – Communications Cable Management
14. Section 27 13 00 – Communications Interior Backbone Cabling

1.2 References

A. Usage: In accordance with Section 01 42 00 – References.
B. In addition to the requirements of Section 27 05 00 - Common Work Results for Communications and 27 10 00 - Structured Cabling, Basic Materials and Methods, conform to the applicable portions of the following standards agencies:

1. BICSI
   a. 2004 Customer Owned Outside Plant Design Manual, 3rd Edition.
2. Insulated Cable Engineers Association (ICEA)
   a. ICEA S-56-434 (1983, 5th Ed.) Polyolefin Insulated Communication Cables for Outdoor Use.
3. Underwriters Laboratories, Inc. (UL)
   a. UL 497 (1995, R 2001) Safety(Dec. 15, 1978, 4th Ed.; Rev. thru Oct. 9, 1990) Protectors for Communications Circuits
4. U.S. Department of Agriculture, Rural Utilities Service (RUS), formerly Rural Electrification Administration (REA):
   a. RUS/REA Bulletin(Jan. 1993; Supp 1 thru 7) 1755I-100 List of Materials Acceptable for Use on Telephone System of REA Borrowers.
   b. RUS (REA) PC-2(Jan. 1978) Splicing Standard.
   c. RUS (REA) PC-4(July 1976) Acceptance Tests and Measurements of Telephone Plant.
   d. RUS (REA) PE-22(No. 1982) Aerial and Underground Telephone Cable.
   e. RUS (REA) PE-33(Mar. 1985) Shield Bonding Connectors.
   f. RUS (REA) PE-39(June 1993) Filled Telephone Cables.
   g. RUS (REA) PE-60(Sep. 1979) Trunk Carrier Systems.
   h. RUS (REA) PE-74(Oct. 1985) Filled Splice Closures.
   i. RUS (REA) PE-87(Dec. 1983) Terminating (TIP) Cable.
   j. RUS (REA) PE-89(June 1993) Filled Telephone Cable with Expanded Insulation.
   k. RUS (REA)TECM 644(Apr. 1983; Issue No.3) Design and Construction of Underground Cable (Physical Plant).
   l. RUS (REA)TECM 823(Aug. 1980; Issue No. 3) Electrical Protection by Use of Gas Tube Arrestors.

1.3 SUBMITTALS

A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and Section 27 05 00 - Common Work Results for Communications.

1.4 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 - Product Requirements and Section 27 10 00 – Structured Cabling, Basic Materials and Methods.

1.5 Sequencing

A. Not Used.

PART 2 - PRODUCTS

2.1 Fiber Optic Cabling

A. General Requirements
   1. As specified in Section 27 10 00 – Structured Cabling, Basic Materials and Methods.

B. Fiber Optic Cable, Outside Plant:
1. Drawing References:
   a. XX FOM-OP Multimode, where XX indicates fiber count.
   b. XX FOS-OP Singlemode, where XX indicates fiber count.
   c. XX FOH-OP Hybrid, where XX indicates total fiber count. Ratio of Single mode to Multimode within overall count is 1:1, unless otherwise noted.
2. Refer to Section 27 10 00 – Structured Cabling, Basic Materials and Methods, including Fiber Cable Construction, General, Fiber, Multimode, General, and Fiber, Single Mode Strands, General, as applies.
3. Application: Inter-building site distribution in manholes and site conduit. Conform to NEC limits on placement within building envelope.
4. Listing: NEC OFN, Listing by nationally recognized testing agency.
5. Construction:
   a. Suitable and approved for wet location/direct burial
6. Provide Loose Tube Gel Filled Construction
   a. Tubes: Up to 12 fibers per tube.
   b. Multiple fibers per tube.
   c. Kink resistant construction within bend radius specified.
   d. Gel Free
   e. Overall Construction.
      i. Inorganic, non-hygroscopic binder fill provided to supplement and support uniform cable construction as required.
      ii. Buffer tubes stranded around central support member using “S-Z” process, left hand lay.
      iii. Binders to be applied with sufficient tension to secure buffer tubes to the central member without crushing buffer tubes.
      iv. High tensile strength dielectric yarns helically woven around cable core to provide tensile strength.
      v. Tight Buffer Construction Option
   f. Water blocking, per EIA/TIA-455-82B
   g. Optical fibers surrounded by 250 µm primary polymer buffer and 900 µm strippable PVC secondary buffer.
   h. Jacket:
      i. Polyethylene, polyurethane or PVC.
      ii. 0.040" minimum thickness.
   i. Maximum Cable Diameter:
      i. 2-72 strands: 0.48”
      ii. 73-96 strands: 0.54”
      iii. 97-144 strands: 0.69”
      iv. 145-216 strands: 0.70”
      v. 217-288 strands: 0.79”
7. Performance:
   a. Maximum attenuation per EIA/TIA-455-61
      i. Multimode
      ii. 850 nm: ≤ 3.0 dB/km
      iii. 1300 nm: ≤ 1.0 dB/km
   b. Singlemode

i. 1300 nm: ≤ 0.4 dB/km
ii. 1383 nm: ≤ 0.4 dB/km
iii. 1550 nm: ≤ 0.3 dB/km

c. Maximum required bend radius:
i. At installation: 20x's diameter
ii. Long term application: 10x's diameter

d. Zero water entry per FOTP-82, 24 hours immersion.

e. Maximum Tensile Loads
i. Short-Term: 2700 N (600 lbf)
ii. Long-Term: 890 N (200 lbf)

f. Temperatures
i. Storage: -40° to +70°C (-40° to +158°F)
ii. Installation: -30° to +70°C (-22° to +158°F)
iii. Operation: -40° to +70°C (-40° to +158°F)

g. Suitable for Outdoor lashed aerial and duct and direct-buried; indoor when installed according to California Electrical Code Article 770

8. Manufacturer
a. Loose Tube:
i. Corning Cable Systems Altos Lite Gel-Free, Single-Jacket, Cables
ii. Commscope/Systimax
iii. Commscope Uniprise
iv. General
v. Berk-Tek
vi. Mohawk
vii. Superior Essex
viii. or equal.

C. Optical Fiber Splice Closure:
1. Drawing Reference: FOSC
2. Functions/Features:
a. Provide re-enterable underground or inside plant splice closure as shown on the Drawings.
b. Plastic construction – no corrodable materials.
c. Waterproof, suitable for direct burial.
d. Fusion splice protection chamber
e. Grommet cable entrance and exits.
3. Manufacturers
a. Preformed Line Products Coyote Series.
b. Corning Cable Systems
c. ADC
d. Commscope/Systimax Inc.
e. 3M
f. or equal.

2.2 Copper OSP Cabling

A. Telephone, Outside Plant, Underground in Ductbank
1. Drawing Reference: T-OPD, with pair counts as indicated.
2. Features/Functions:

a. Solid round copper wire, individually bound per REA PE-39 color coded.
b. Meets RUS REA 1755.390
c. Solid aluminum tape overall shield.
d. Gel filled.
e. Polyethylene Overall Jacket.
f. Suitable for direct burial.
g. 6 to 3000 Pair counts available.

3. Manufacturer:
   a. Alcatel
   b. Superior/Essex
   c. General Cable
   d. NORDX/CDT
   e. Any meeting REA PE-39 for cable smaller than 400 pair,
   f. Any meeting REA PE-39 or REA PE-89 for cable 400 pair or larger.
   g. or approved equal.

B. Shield Connectors:
1. Shield connectors shall make a stable, low-impedance electrical connection between the shield of the communications cable and a conductor such as a strap, bar, or wire.
2. The connector shall be made of tin-plated tempered brass.
3. Shield bond connectors shall comply with REA PE-33.

C. Grounding Braid:
1. Grounding braid shall provide low electrical impedance connections for dependable shield bonding.
2. The braid shall be made from flat tin-plated copper.

2.3 Outside Plant Telephone Cabling Closures

A. In Building Telephone Closure:
1. Drawing Reference: IBTC
2. Features and Functions:
   a. Provides transition point from unlisted, gel-filled Outside Plant Cabling to Interior (CU) cabling
   b. Can house a straight, butt, and branch splice in a protective housing.
   c. Not pressurized or encapsulated.
   d. Fire-retardant Plastic construction, meeting PUB55006 for interior (in-building) installation.
   e. Provide a suitable means for mounting to backboard.
   f. End Caps
      i. Multiple End caps shall be sized precisely to fit the diameter of the tip cables entering the closure.
      ii. Number of openings in the multiple end caps shall be determined by dividing the number pairs in the feed cable by 100 and doubling that number. (ie. 1200 pair cable would have 24 openings for tip cables.
      iii. Collared Cap opening can be up to 6.35mm (1/4") larger than the feed cable diameter.

iv. Actual end cap to be provided shall be based on the diameter of the feed cable to be spliced.

g. Plugs
   i. Use tapered or collared plugs as required to fill extra opening in end caps.
   ii. Seal if inside diameter of hole is less than 6.35mm (.25").

h. Bushings
   i. Use rubber or variable bushings as required to reduce standard opening in end caps to accommodate custom diameters.
   ii. Seal if inside diameter of hole is less than 6.35mm (.25").

i. Lubricants
   i. Lubricant shall evaporate and shall not damage closure elements in any way.

3. Manufacturer:
   a. UraSeal 2000FR Type.
   b. 3M K&B Series
   c. Tyco Electronics
   d. or equal.

B. Outside Plant Telephone Closure, Vault
1. Drawing Reference: OTC, TOSC
2. Features/Functions
   a. Stainless Steel outer jacket housing
   b. Can house a straight, butt, and branch splice in a protective housing.
   c. Rigid outer protective body
   d. Suitable for periodic water immersion - air and watertight.
   e. Renter able.
   f. Gel Filled, Injected encapsulant using precision means
   g. Minimum inside diameter shall be 5" (127mm).
   h. Minimum inside length shall be 26" (660mm).
3. Approvals
   a. RUS - Rural Utilities Service, USDA
4. Manufacturer:
   a. Preformed Line Products Armadillo Stainless.
   b. UraSeal
   c. 3M
   d. Emerson Network Power
   e. or equal.

C. Multipair Splicing Connectors
1. Drawing Reference:None. Provide at all IBTC, TOSC, OTC and similar locations where shown on the plans or required in the field.
2. Function:
   a. Can gas tight terminate large pair counts of copper cabling to connectorized ends and reliable mate ends in compact area.
   b. Industry standard termination means.
   c. Provide in quantity equal to largest number of pairs found on either of the two cables being spliced.
   d. All modules shall have test entry ports on the front side of the module.

e. All straight splicing modules shall be tap modules.

3. Manufacturer:
   a. 3M 710 (Industry standard item).
   b. or equal as required to match the standard used at the facility.

2.4 Miscellaneous Underground Products

A. Bonding Ribbon:
   1. Annealed solid copper 3/8 inch wide x 1/16 inch thick, tin plated.
   2. Manufacturer:
      a. Inwesco 12A55
      b. Tyco Electronics
      c. Thomas and Betts
      d. Preformed Line Products.
      e. or equal.

B. Bonding Ribbon Clamp:
   1. Soft lead
   2. 1/16 inch thick
   3. Bolt hole for attachment
   4. Manufacturer:
      a. Inwesco 12A56
      b. Tyco Electronics
      c. Thomas and Betts
      d. Preformed Line Products.
      e. or equal.

C. Fargo Clamp:
   1. Cast copper, silver plated, furnished with copper bolt.
   2. RUS Listed
   3. Manufacturer:
      a. Allied Bolt
      b. Inwesco 12A57
      c. Tyco Electronics
      d. Thomas and Betts
      e. or equal.

D. Encapsulant
   1. Encapsulates shall be transparent.
   2. Encapsulant shall be on low viscosity to allow it to penetrate around connectors and wires.
   3. Splice case and Encapsulant must be re-enterable; the Encapsulant must easily come off hands.
   4. Must possess sufficient tack to adhere well to the splice components during expansion and contraction caused by temperature changes.
   5. When new gel is poured it must bond thoroughly to existing gel in the closure.
   6. Shall be compatible with the cable insulation.
   7. Shall not be corrosive to copper and must not support fungi or mold growth.
   8. Shall cure quickly. (20- 30 minutes)

E. De-Gel Stripper
   1. Shall be non toxic.

2. Shall be compatible with the cable insulation.
3. Shall not be corrosive to copper.

PART 3 - EXECUTION

3.1 General

A. Provide safety barriers and flag persons for all open manholes and pullboxes that are located in areas accessible to the public.
B. Provide traffic control in accordance with the requirements of Section 01 56 00 Temporary Barriers, Enclosures and Controls.
C. Conform to OSHA guidelines when accessing manholes and handholes, inclusive of the requirement for air sampling. Provide continuous measurements. Provide the Owner's Representative with contractor maintained logs of air samples taken at most two hours apart.
D. Provide sufficient personnel to permit one individual to remain above the surface at all times, in visual contact with persons in manholes and similar. Provide the observer with an appropriate means of obtaining assistance.
E. Provide ladders for access to manholes. Do not permit workers to use cables or splice cases as ladders.
F. Install a 3/8" nylon pullrope with all underground cables.

3.2 Cable Pulling

A. Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables.
B. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation.
C. Use flexible cable feeds to convey cables through manhole opening and into duct runs.
D. Accumulate cable slack at each manhole or junction box where space permits by training cable around the interior to form one complete loop.
E. Maintain minimum allowable bending radii in forming such loops.
F. Do not exceed the specified cable bending radii when installing cable under any conditions, including turnups into outdoor pedestals or other enclosures.
G. Cable with tape shield shall have a bending radius not less than 12 times the overall diameter of the completed cable.
H. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.
I. OSP Copper Cabling Special Procedures
   1. All open ends of the cable shall have sealing/pulling caps installed at the factory prior to shipping so that infiltration of moisture between shipment and installation is prevented.
   2. Contractor shall provide notice 2 days in advance notice prior to pulling any cable greater than 400 pairs in size or when a winch is planned for use.
   3. Owner's Representative shall have the option to be present to observe all pulling activities of cable greater than 400 pair or when a winch is planed for use.
   4. Cable bend radius shall be at least 10 times the diameter of the cable.

5. Contractor shall be responsible for verifying that ducts are ready for occupancy prior to cable placement.
6. Contractor shall assume responsibility for any difficulties or damage to the cable during placement.
7. Cable feeder guides shall be used between the cable reel and the face of the duct.
8. Cable shall be watched and inspected for sheath defects, as it is payed off the reel. Pulling operation shall be stopped and Owner's Representative shall be notified if a defect or any other irregularity is found.
9. Cable shall be payed out from the top of the reel.
10. Adhere to all manufacturers requirements regarding pulling tension allowable lubricants and bending radius.
11. Use Line Tension meter and 600 lb pulling swivel during cable pulls to provide accurate measurement of the force exerted on a cable as it is installed. The meter shall have a visual indication of an overload condition.
12. Secure all cables and splice cases as required with heavy duty tie-wraps to T-slot cable racking and steps.
13. Cable shield shall be continuous from end to end.
14. All un-terminated cable pair ends must be cleared (not shorted or crossed) and binder tagged.
15. All open ended cables must be watertight sealed using temporary end caps or encapsulation.

3.3 Cables in Manholes, Pull Boxes and Handholes

A. Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths.
B. Form cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators.
C. In existing manholes and handholes where new ducts are to be terminated or where new cables are to be installed, locate the existing installation of cables, cable supports and grounding as required for a uniform installation with cables carefully arranged and supported.
D. Install fiber cable inside conduit with split-duct innerduct to protect and provide visual identification through the Maintenance Hole's, Pull-boxes, Christy Boxes, and vaults.
E. Support cable splices in underground structures by racks on each side of the splice.
F. Located splices to prevent cyclic bending in the spliced sheath.
G. Copper Splicing Modules.
   1. All multipair splicing modules shall be tap modules and have an integrated encapsulate for outside work and air tight for inside environments. (ISP and OSP).
   2. The module shall create a gas tight connection.
H. Install cables at middle and bottom of cable racks, leaving top space opening or future cables, except as otherwise indicated for existing installations.
I. All conduit that enters a building shall be plugged in the last vault or box prior to entering the building.

3.4 Service Loop and Transition Splice at Building Entry

A. For outside plant, flooded cables of 100 pair or greater entering a Building Distribution Facility or Entrance Facility, provide a transition in a splice case, Type IBTC, to non-flooded cable prior to termination on the protector blocks. Unless otherwise indicated on the plans, position the splice case high on the backboard, parallel to the floor at location suitable for service and where gel will not be drawn from the serving outside plant cabling into the IBTC.

B. At Telecommunications Rooms (including IDF/HC's and BDF/EF's), at both ends of cables, provide at least 20 feet of cable in excess of that required to reach the protectors or terminal block by a dressed route. Form into a storage loop, typically around the perimeter of the backboard and fix in place as directed by the Owner's Representative.

C. Bonding Harnesses shall be used to ground the shields of the spliced cables to the TGB or building service ground. Bonding harness shall be 14 AWG and sized according to closure.

D. Refer to Section 27 13 00 - Communications Indoor Backbone Cabling for additional requirements for termination within Telecommunications Rooms.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes, but is not necessarily limited to provision of:
   1. Horizontal Station Cabling
      a. Horizontal copper station cabling, meeting ANSI/TIA Category 6 standards, homerun from receptacles to indicated IDF/TR or BDF. Terminated on rack mounted patch panels, as indicated.
   2. For all cabling:
      a. Terminate on patch panels as specified in Section 27 11 19.
      b. Test cabling to demonstrate performance to specified standards or better using test equipment and methods as specified in Section 27 10 00.
      c. Label cables, jacks, plates and patch panels as specified in Section 27 05 53.
      d. Document on Record Documents as described in Section 27 05 00.

B. Related Work in Other Sections:
   1. Section 27 10 00 – Structured Cabling, Basic Materials and Methods
      a. Performance and execution standards that apply to the work of this section.
   2. Section 27 05 29 – Hangers and Supports for Communications Systems
      a. J-hooks and hangers for the work of this Section
   3. Section 27 05 53 – Identification for Communications Systems
      a. Labeling systems and execution for the work of this Section.
   4. Section 27 11 19 – Communications Termination Blocks and Patch Panels
      a. Specification for patch panels and blocks used by work of this Section.
      b. Execution standards for installation of Owner furnished network switches.
   5. Section 27 11 23 – Communications Cable Management
      a. Specification for innerduct, backboard and patch cord management used by the work of this Section.
   6. Section 28 23 00 – Video Surveillance
      a. Work of this section provides structured cabling used by Visual Surveillance Systems.

1.2 References

A. Usage: In accordance with Section 01 42 00 – References.
B. As listed in Section 27 05 00 - Common Work Results for Communications and 27 10 00 - Structured Cabling, Basic Materials and Methods.

1.3 Submittals

A. Conform with the requirements of Section 01 33 23 - Shop Drawings, Product Data and Samples and 27 05 00 - Common Work Results for Communications.

1.4 Delivery, Storage and Handling

A. Procedures: In accordance with Section 01 61 00 - Product Requirements and 27 05 00 - Common Work Results for Communications.

1.5 Sequencing

A. Coordinate the installation of the horizontal cabling with the other work of this Project, or Projects simultaneously in progress in each building of the project. The Contractor shall ensure that construction and preparation of the rooms and spaces in which the work of this Section are to be installed are sufficiently complete before beginning work.

B. Removal, replacement and re-installation of communications materials and equipment required to permit the completion or correction of other building trade work that is the work of this Project shall be done at no cost to the University or impact to the project schedule.

1.6 Definitions

A. Copper Patch Cord. A modular Category 6E interface cord installed within a Telecommunications Room.

B. Station Cord. A modular Category 6E interface cord installed between the work area outlet and the Owner furnished equipment that it serves.

PART 2 - PRODUCTS

2.1 Modular Jack Components, General

A. Intent

1. In order to provide for ease of long term maintenance, the Owner has adopted a single dimensional standard for modular jack openings and faceplates to match existing conditions on the campus.

B. Definitions

1. Keystone Opening: A communications industry standard rectangular opening in a wall plate or patch panel having nominal dimensions of 0.58" wide and .76" high and designed to securely mount industry standard keystone jacks.
2. Keystone Jacks:
   a. A communications industry standard rectangular cable end termination with a front face having a nominal front face width of .575" and a height of .66".
   b. The body of the jack is not significantly wider than the front face of the jack (less than 0.70”), permitting jacks to be installed adjacent to one another in industry standard multi-jack plates and patch panels.
   c. The top of the jack features a compressible locking tab; the bottom a ridgeline.
   d. The overall height of the jack from the bottom of the jack face to the flat top surface of the undepressed tab shall be nominally .78 inches.

e. When the tab is depressed, a jack can be inserted or released from the opening. Once released, the jack is locked in place by the by the ridgeline at the base and the upward force of the tab.

C. Intervendor compatibility
1. Keystone Jack Compatibility test.
a. Any jack or panel system proposed as meeting the keystone compatibility requirements of this specification shall be able to interchangeably mount or mount in (as applies) Leviton Quickport series components.
Systems exhibiting excess play, inability to insert, inability to remove, damage to the plate or jack or occupying excessive area behind the plate opening will not be accepted.

2.2 Copper Cabling, Category Rated Data/Voice

A. General
1. Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with EIA TIA/EIA-568-C.1.
B. High Speed, TIA/TIA Category Cabling, Plenum Rated
1. Drawing Reference: UTP6-4P
2. Construction:
a. Provide horizontal copper cable in accordance with:
i. EIA ANSI/TIA/EIA-568-C.2,
ii. UL 444,
iii. NEMA WC 66 (Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pair)
iv. ICEA S-90-661
b. UTP (unshielded twisted pair),
c. 100 ohm impedance
d. Four each individually twisted pair, 22 - 24 AWG conductors,
i. Color code
(1) Pair 1 White/Blue Blue
(2) Pair 2 White/Orange Orange
(3) Pair 3 White/Green Green
(4) Pair 4 White/Brown Brown
e. No shield in the sheath.
f. Jacket
i. Provide communications plenum (CMP) rated cabling.
ii. UL listed, NEC compliant for plenum installation.
iii. Color: Blue – Match color of cable to color of jack at the faceplate in accordance with the details on the plans.
iv. Cable imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 2 feet.
v. The word "FEET" or the abbreviation "FT" shall appear after each length marking.
3. Certification

a. Warrantied by the manufacturer to provide Category 6 performance when installed in accordance with applicable ANSI/TIA standards and when terminated with the jacks supplied by the Contractor for this Project.

4. Performance
   a. Assembly electrically meets or exceeds ANSI/TIA-568-C.2 Category 6 performance standards
5. Manufacturers:
   a. Berk-Tek LANmark-6
   b. Berk-Tek LANmark-1000
   c. Amp
   d. Belden/CDT
   e. Commscope/Systimax
   f. Commscope/Uniprise
   g. General Cable
   h. Hitachi
   i. Mohawk/CDT
   j. NORDX/CDT
   k. Superior/Essex
   l. or equal.

C. High Speed, Category 6 Cabling, Plenum Rated
1. Drawing Reference:** UTP6-4P, where ** denotes cable count
2. Construction:
   a. As for non-plenum, with fire retardant overall jacket construction.
   b. National Safety Agency – UL or ETL listed, NEC compliant for plenum installation.
3. Manufacturers
   a. As for non-plenum Cat. 6, plenum construction.

D. High Speed, Category 6 Cabling, Outside Plant
1. Drawing Reference: ** UTP6-4OP or UTP6-OSP, where ** denotes cable count.
2. Construction:
   a. Exceeds TIA/EIA 568-C.2 CAT 6, ISO/IEC 11801:2002 CAT 6, & IEC 61156-5 CAT 6 Horizontal Cable
   b. Suitable for placement in duct below grade subject to extended exposure to standing water. Cable includes flooded construction for moisture protection.
   c. Jacket: Water resistant linear low density polyethylene or equivalent construction.
   d. Inner jacket: Water resistant linear low density polyethylene or equivalent construction.
   e. Insulation: Solid polyolefin or equivalent construction.
   f. Filling Compound: 80 degree centigrade extended thermoplastic rubber or equivalent construction.
3. Manufacturer
   a. Mohawk VersaLAN OSP Category 6
   b. BerkTek
   c. CommScope

d. General/Essex.
e. Belden.
f. or equal.

2.3 Work Area Outlets (WAO)

A. Category 6 Data Jacks Performance Requirements, General
1. Jack
a. Construction:
i. High impact, flame retardant UL-rated 94V-0 thermoplastic.
ii. The jack shall be designed with an integral locking mechanism which, upon insertion of a modular plug, provide maximum pullout strength at the plug/jack interface.
b. Performance - The jack shall meet or exceed the following standards.
i. TIA/EIA 568 C.1
ii. CSA Certified
iii. UL listed
iv. FCC Part 68, Subpart F
v. Electrical - The modular jacks shall meet the following electrical performance and certification requirements.
vi. Insulation resistance - 500 MΩ maximum
vii. Dielectric withstand voltage
(1) 1000 VAC RMS, 60 Hz minimum, contact to contact
(2) 1000 VAC RMS, 60 Hz minimum to exposed conductive surface
(3) IEEE and Cisco Power over Ethernet power dissipation standards.
viii. Contact Resistance - 20 mΩ maximum
ix. Current Rating - 1.5 amps at 68 degrees F (20 degrees C) per IEC Publication 512-3, Test 5b.
c. Physical - The modular jacks shall meet the following physical requirements.
i. Connector-insulation displacement connectors accepting 22 - 26 gauge AWG solid or stranded conductor wire.
ii. Jack wires-square copper alloy wires with 50 micro-inch lubricated gold plating over 100 micro-inch nickel plate
iii. Stamped crossover lead frame conductor paths
iv. Wired to meet EIA 568C.1 and T568B Color Code
v. Color:
(1) Jacks: Blue.
(2) Blank jack cover: White or ivory to match plate.
vi. “C6” or equivalent molded on face of jack.
d. Mechanical - The modular jacks shall meet the following mechanical requirements
i. Plug insertion - minimum 750 plug insertions
ii. Contact Force - 100 grams minimum using FCC-approved modular plugs

iii. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack
iv. Temperature Range: -40 to 150 degrees F
e. Meets modular jack opening constraint is defined elsewhere in this Section.
2. Blank connector modules.
a. Features.
i. Snaps into faceplate, fills blank openings.
3. Manufacturers – Jacks:
a. Leviton eXtreme 6+ Connector
b. Panduit Netkey Keystone Jacks
c. Hubbell NextSpeed Xcelerator
d. ADC/Krone
e. AMP SL Series – 1375187 Category 6 jack.
f. Hellerman-Tyton Megaband
g. Ortronics Keystone.
h. 3M
i. Siemon Max 6 MX5-K series
j. or equal.
4. Manufacturers - Blank Module.
a. Leviton Snap-In Blank Module
b. Hubbell SFB
c. equal by listed jack manufacturers
d. or equal.

B. Telecommunications Outlets, Copper Jacks, Wall Mount, Flush
1. Drawing Reference(s):
a. MMP4
b. MMP6
2. Assembly. Provide complete telecommunications outlet assembly, including but not limited to:
a. Faceplate with industry standard keystone openings
b. Blank connector modules at faceplate openings not filled with connector modules.
c. Labels and label holders.
3. Faceplate.
a. Features:
i. Single gang.
ii. Front Loading
iii. Openings for up to 4 keystone jack connector modules – MMP4, up to 6 openings – MMP6.
iv. At wall mount locations calling for 4 jacks or fewer, provide with 45 degree angled openings for jacks relative to the place of the faceplate, oriented along the long edge of the plate.
v. At other locations, including wall mount locations with more than 4 jacks, or inside floor boxes or above ceiling, provide with flat face faceplates.
vi. Label holders with space to label the plate number and the number of each jack.

b. Color: To match electrical receptacles and switch plates mounted on same wall,

4. Manufacturers - flat plates, subject to keystone interchangeability requirement:.
   a. Leviton Quickport Multimedia MOS Single Gang Wall Plates and Adapters.
   b. Panduit Netkey.
   c. Hubbell InfineStation Series Faceplates and Adapters
   d. AMP SL Series plates and Adapters
   e. ADC/Krone
   f. Hellerman Tyton Modular Faceplates
   g. 3M
   h. Ortronics Keystone
   i. Lutron keystone.
   j. or equal.
5. Manufacturers - angled exit plates
   a. Leviton Quickport Multimedia MOS Single Gang Wall Plates with 41294-2Q QuickPort MOS Simplex 1.5U High Module Adapters
   b. Panduit Netkey with Angled Adapters.
   c. Hubbell InfineStation Series Faceplates and Keystone 2 port Angled Adapters
   d. AMP SL Series plates and Angled Adapters
   e. ADC/Krone with Angled Adapters
   f. Hellerman Tyton Modular Faceplates with Angled Adapters
   g. 3M with with Angled Adapters
   h. Ortronics TechChoice with Angled Adapters
   i. Lutron keystone.
   j. or equal.

C. Duplex Jack Frame, 1 To 4 Receptacles
1. Drawing Reference: DJF4
2. Construction:
   a. Supports jacks as listed for MMP6 in a duplex electrical opening (NEMA 106 format).
   b. Modular, with keystone snap-in receptacle options as scheduled.
   c. Options for 1 to 4 receptacles per plate
   d. Otherwise as for MMP6 above.
3. Manufacturers:
   a. Leviton 41087-Q*P
   b. Pass & Seymour AC-QP106
   c. Hubbell.
   d. Manufacturers listed for MMP6 above
   e. or equal.

D. Voice Telephone, Station Plates & Jack/Receptacles
1. Drawing References:
   a. Wall Mounted Telephone, Flush:
   b. 630A
2. Station jacks shall be modular four or 8 wire type and conform to FCC Part 68.

3. Construction, where not otherwise specified, scheduled or indicated:
   a. Cat 6 Modular as specified above.
   b. Jack is fully recessed behind plate.
   c. Spring Wire Contacts, at least 50 microinches gold on 100 microinches nickel.
   d. Mechanically fastened to Building or Similar. Adhesive fastening not acceptable.
   e. Stainless Steel or High Strength 94VO plastic.
   f. Mounts to Single Gang Ring, Single Gang Box or Surface Mounted to Wall or to opening in Surface Raceway - Refer to Schedule on Plans.
   g. Single Gang Wall Plate with two integral wall telephone mounting studs.
   h. Insulation displacement (punchdown) termination.
4. Manufacturers, Flush Wall Mounted Wall Telephone.
   a. Hubbell P630S1GJ8.
   b. Leviton 4108W-OSP
   c. or equal using listed plate and jack from one of the listed manufacturers to Category 6 jacks elsewhere herein above.
   d. or equal.

E. Modular Furniture Receptacle Plates, 1 To 4 Receptacles, Universal Fit
1. Drawing Reference: OMP
2. Construction:
   a. Modular, with snap-in receptacle options as scheduled.
   b. Universal fit adjustable latches plate bezel mount fits at least Haworth - Premise, Knoll Ref and Steelcase systems.
   c. Colors of plates, mounting screws and inserts to be selected by Contracting Officer.
   d. Options for 4 jacks per plate.
   e. Otherwise as for MMP6 above.
3. Manufacturers:
   a. As for MMP6
   b. or equal.

F. MultiMedia Surface Mount Box
1. Drawing Reference (s):
   a. * MMSB, where * represents the number of Category connectors of the type specified elsewhere herein.
   b. Biscuit Box
2. Features Functions
   a. Surface mount enclosure holds terminated station cabling with Category connectors parallel to face of mounting surface.
   b. Mechanically fastened to enclosure surface.
   c. 2 part assembly includes fixed mounting base plate and removable cover over terminations
3. Manufacturers:
   a. Leviton Quickport Surface Mount Boxes
   b. Panduit Netkey
   c. Hubbell

d. AMP
Or equal

PART 3 - EXECUTION

3.1 Signal Polarity and Color Code Convention

A. Category 6 Station Wire, RJ45 - Per ANSI/TIA-568C, designation T568B

3.2 Station Cable Installation and Termination Procedures

A. General:
1. All station cable, between the station outlets and the IDF terminal blocks, shall be continuous unspliced runs.
2. Station cable shall run loose throughout all pathways. At no time shall any station cable be secured by a tywrap, electrical tape or similar bindings.
3. At Cable Trays in Telecommunications Rooms, bundle station cable loosely into a bundle using velcro wraps applied at 3'-0" o.c. typically. At no time permit the cables to be deformed by such cable bundling.
4. All exposed wiring shall be installed in surface raceway.
5. All wiring above ceilings shall be installed in cable tray or open top cable hangers.
6. Cable above accessible ceilings shall be supported 4' on center (min) from cable support attached to building structure.
7. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
8. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90 degree sweeps at all vertical drops.
9. Maintain the following clearances from EMI sources.
   a. Power cable - 6 in.
   b. Fluorescent Lights - 12 in.
   c. Transformers - 48 in.
10. Cables jackets that are chaffed or burned exposing internal conductor insulation or have any bare copper ("shiners") shall be replaced.
11. Firestop all openings where cable is installed through a fire barrier.

B. Run Lengths:
1. Mockup prior to proceeding
   a. Contractor to field verify the performance of the proposed installation in a mockup using the proposed cabling, jacks, raceway and listed test equipment prior to proceeding.
      i. Contractor to install (1) One typical copper work area outlet complete with jacks at both ends, utilizing the proposed pathway and cabling.
      ii. Contractor to install all labeling for this mockup
      iii. Contractor to perform testing of this mockup using the specified test equipment and procedures.
      iv. Results are to be inspected and reviewed by the Owner's Representative prior to proceeding with the rest of the installation.
      v. Any deficiencies in the installation of the mockup are to be

corrected by the Contractor and re-inspected by the Owner's Representative prior to proceeding with the rest of the installation.

2. Station, Horizontal and IDF/HC Links:
   a. Horizontal Distribution runs (including vertical portions) shall not exceed 295 feet from station outlet to the associated Telecommunications closet.
   b. Station cabling runs to be 10 feet) or less.
   c. IDF/HC room distribution wiring not to exceed 19.5 feet
   d. Alternately, total length not to exceed 328 feet.
   e. Report to the Owner's Representative conditions exceeding these requirements.
3. Limit cable bends to a minimum radius of 8 times cable diameter except where otherwise noted herein.
4. Termination shall not untwist more than 1/2 inch of cable maximum from the manufactured condition.
5. Service loop at Station
   a. Copper. Provide slack, which is to be no less than 2.5" and no greater than 5.0", in the station cable at the station outlet end. This is to allow the Work Area Outlet to be removed from the outlet box and visually inspected without leaving so much wire in the box that it might become accidentally damaged during installation.
   b. Fiber Station Cabling. Provide 3 feet of slack fiber storage at the station, neatly coiled on the fiber management provided within the FMP enclosure, at least 10 inches at OMP.
6. Termination of wiring at the station outlet:
   a. All data and voice station cable shall be terminated at the individual receptacle modules in accordance with ANSI/TIA-568-C, assignment T568B. Unless otherwise indicated, load jacks in faceplates in the manner detailed in the drawings.
   b. Termination of wiring at existing station outlets:
      i. Install in data and voice inserts in place of existing blank insert in existing faceplate.
      ii. Install new labels and label holders.
7. Termination of station wiring at the IDF/HC
   a. For the installation/layout of station cable within the IDF/HC rooms, see detail on drawings.
   b. Data cabling is to be installed in the center of the rear rack rails (or trough) within the rack, not the wire manager.
   c. All Category 6 station cables entering the IDF/HC room will be terminated on a Category 6 RJ45 jack mounted in a Patch Panel as specified in Section 16765 – Communications Termination Blocks and Patch Panels. Horizontal cabling in the closet shall be installed equally between the first and third racks, in a three rack installation, separated by one empty between cable racks in each TR. Cabling shall be split as 1-48 in the first rack, 49 thru 96 in the third and back to the first for additional cabling. Single rack TR's are exempt from this alternating method.
   d. Fiber station cabling will similarly be terminated on rack mounted patch panels.

e. Termination shall begin at the upper left corner of the path panel and proceed to the right continuing down, left to right until all cables are terminated.

8. Special Phone Applications:
   a. All Alarm, Wall Phone, House Phone, Pay Phone and other similar services requiring a cable and jack to be labeled consistent with data cables. Such circuits are to be run as a data cable and placed into the data racks in a patch panel and marked accordingly. If a voice cable is requested a blue jack is simply terminated at the end of a data cable.
9. Security Camera Locations:
   a. Provide a (10') Ten Foot Slack Loop for the Data Cables at each Camera Location to allow for minor repositioning.
10. WAP Locations:
   a. Provide a (10') Ten Foot Slack Loop for the Data Cables at each WAP Location to allow for minor repositioning.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Sound and Audiovisual System work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems.

B. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of the Work of this Section. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction.

1.2 SYSTEM FUNCTIONS

A. Provide the following, in addition to work shown on the drawings and specified in Parts 2 and 3 below:

B. Loudspeaker/Audio Processing, general

1. Program audio and speech content to output through overhead loudspeakers.

C. Racking compartment, general

1. Provide blank plates at all unused openings.
2. Provide fans as required to keep the interior of each equipment rack at a temperature of at least 5-10 degrees cooler than equipment manufacturer's recommended operating temperature.
   a. Fans to not emit more noise than 30 dB.

D. Controls Systems, general

1. Review all push button and touchpanel button nomenclature with Owner's Representative prior to system programming.
2. Provide graphic indication of program volume level on control touchpanel when volume control is selected.
3. Provide Main menu selection button on all touchpanel screens to route user back to main touchpanel menu.

E. Control Functions

1. Control: Confirm all control functions and layouts with Owner's Representative prior to system programming. Program control interfaces similar to recently completed Mission College projects.
2. Wall Control:
   a. General: Functions to operate by scene/mode, not by device.
      i. End user selection of a single A/V input source (push buttons) automates:
         (1) Projection screens lower

(2) Projectors turn on
(3) Presets recalled
(4) Sets audio chain to loudspeakers

ii. End user selection on an Audio Only input automates:
(1) Sets audio chain

iii. Control Push Button Selections
(1) Audio Mute
(2) Video Mute
(3) Program Volume
(4) Power Off

iv. Touchpanel Menus
(1) Startup Page: “Press here to begin”
(2) Home Page:
(a) “Select Source”: Provides sub-menus of source selections:
(b) PC
(c) Blu-Ray
(d) Laptop HDMI
(e) Laptop VGA + mini stereo audio
(f) AUX HDMI
(g) AUX VGA + mini stereo audio
(h) Mini Stereo audio only
(i) “Controls”: Provide sub-menu of:
(j) Screen up/down control
(k) Individual projector on/off control
(l) “Power Off”: Provides sub-menu selection of “Do you want to power off the system?” with “Yes” and “No” selections. Upon selection of “Yes”, menu reads “Please wait, shutting down system”
(3) All menus, except Home Page, to include “Home” button to revert back to the Home Page.

1.3 REFERENCE STANDARDS

A. Conform to the applicable portions of the current standards published by these organizations:

1. SMPTE Society of Motion Picture and Television Engineers.
2. NAB National Association of Broadcasters.
3. EIA Electrical Industries Association of America.
4. UL Underwriters Laboratories.
5. AES Audio Engineering Society.
6. NEC National Electrical Code.
7. UBC Uniform Building Code.
8. NFPA National Fire Protection Association.
9. EIAJ Electrical Industries Association of Japan.
10. IEC International Electrotechnical Commission.
11. FCC Federal Communications Commission.
12. NTC Network Transmission Committee of the Video Transmission
    (a) Engineering Advisory Committee.

13. NCTA National Cable Television Association.
14. BTSC Broadcast Television Stereo Committee.
15. TASO Television Allocation Study Organization.

B. Conform additionally to the following specific standards:

1. American National Standards Institute (ANSI)
   a. ANSI S1.4-1983 (R2001) American National Standard Specification for Sound Level Meters
   b. ANSI S1.11-1986 (R2001) American National Standard Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters
   c. ANSI S1.42-1986 (R2001) American National Standard Design Response of Weighting Networks for Acoustical Measurements
   d. ANSI IT 7.214-89 Audio-visual Systems - Front Projection Screens (Tripod/Free-Standing) - Methods for Testing and Reporting Performance Characteristics.
2. Audio Engineering Society Incorporated (AES)
   a. AES2-1984 (r1997) AES Recommended Practice Specification of Loudspeaker Components Used in Professional Audio and Sound Reinforcement
   b. AES5-1998 (Revision of AES5-1984) AER recommended practice for professional digital audio – Preferred sampling frequencies for applications employing pulse-code modulation
   c. AES14-1992 (r1998) AES standard for professional audio equipment – Application of connectors, part 1, XLR-type polarity and gender
   d. AES20-1996 AES recommended practice for professional audio – Subjective evaluation of loudspeakers
   e. AES26-2001 Revision of AES26-1995 AES recommended practice for professional audio interconnections – Conservation of the polarity of audio signals
   f. AES-R2-1998 AES project report for articles on professional audio and for equipment specifications – Notations for expressing levels
3. Electronic Industries Association of America (EIA)
   a. EIA-160 Sound Systems
   b. EIA-310-E Racks, Panels and Associated Equipment
   c. EIA-101-A Amplifiers for Sound Equipment
   d. SE-103 Speakers for Sound Equipment
   e. SE-104 Engineering Specifications for Amplifiers for Sound Equipment
4. International Electrotechnical Commission (IEC)
   a. IEC 268-3 (1988) Sound system equipment – Part 3: Amplifiers
   b. IEC 268-5 (1989) Sound system equipment – Part 5: Loudspeakers
   c. IEC 268-12 (1987) Sound system equipment – Part 12: Application of Connectors for Broadcast and Similar Use
   d. IEC 651 (1979) Sound level meters
5. International Organization for Standardization (ISO)
   a. ISO 1996-1 Acoustics – Description and measurement of environmental noise – Part 1:Basic quantities and – Composite Analog Video Signal – NTSC for Studio

Applications

6. Federal Specifications (FS)
   a. GG-S-00172D Screen, Projection. Federal Supply Classification (FSC) 670.
7. Federal Standards (Fed-Std)
   a. 191A Textile Test Methods.
      i. 5760 Mildew Resistance of Textile Materials; Mixed Culture Method.
      ii. 5903.1 Flame Resistance of Cloth; Vertical.
8. NFPA
   a. 255 Method of Testing Surface Burning Characteristics of Building Materials.
   b. 701 Methods of Fire Tests for Flame-Resistant Textiles and Films.
9. Society of Motion Picture Engineers (SMPTE).
   a. SMPT 196M-86 Motion Picture - Screen Luminance and Viewing Conditions - Indoor Theater Projection Guide.
   b. SMPTE 202M-1998 Motion Pictures – B Chain Electroacoustic Response – Dubbing Theaters, Review Rooms and Indoor Theaters
   c. SMPTE RP167-1995 Alignment of NTSC Color Picture Monitors
   d. SMPTE EG1-1990 Alignment Color Bar Test Signal for Television Picture Monitors
   e. SMPTE EG27-1994 Supplemental Information for ANSI/SMPTE 170M and Background on the Development of NTSC Color Standards (R1999)
   f. RP 94 Recommended Practice for Gain Determination of Front Projection Screens.
   g. SMPTE RP 95 Recommended Practice for Installation of Gain Screens.
   h. SMPTE RP 98 Recommended Practice for Measurement of Screen Luminance in Theatres.
10. Underwriters Laboratories Incorporated (UL)
   a. UL 813 Commercial Audio Equipment 1996
   b. UL 1419 Professional Video and Audio Equipment 1997
   c. UL 1492 Audio-Video products and Accessories 1996
   d. UL 6500 Audio/Video and Musical Instrument Apparatus for Household, Commercial and Similar General Use 1999

1.4 RELATED WORK IN OTHER SECTIONS

A. Division 26 – Power for all equipment

B. Section 27 05 00 – Common Work Results for Communications Systems

C. Section 27 05 26 – Grounding and Bonding for Communications Systems

D. Section 27 05 29 – Hangers and Supports for Communications Systems

E. Section 27 05 33 – Conduits and Backboxes for Communications Systems

F. Section 27 05 36 – Cable Trays for Communications Systems

G. Section 27 05 43 – Underground Duct and Raceways for Communications Systems

H. Section 27 05 48 – Noise and Vibration Control for Communications Systems

I. Section 27 05 53 – Identification for Communications Systems

J. Section 27 10 00 – Structured Cabling for Communications Systems

K. Section 27 11 13 – Communication Entrance Protection

L. Section 27 05 00 – Common Work Results for Communications Systems

M. Section 27 11 16 – Communications Racks, Frames and Enclosures

N. Section 27 11 19 – Communication Termination Blocks

O. Section 27 11 23 – Communications Cable Management

P. Section 27 11 26 – Communication Rack Mounted Power

Q. Section 27 13 00 – Communications Indoor Backbone Cabling

R. Section 27 14 00 – Communications Outside Plant Backbone Cabling

S. Section 27 15 00 – Communications Horizontal Cabling

T. Section 27 41 23 – Communications Broadband Systems

1.5 QUALITY ASSURANCE

A. Test Equipment. Provide in conformance with the applicable requirements of Section 27 05 00 – Common Work Results for Audiovisual Systems. Test systems using at least one (1) each of the following test measurement devices or their functional equivalents:

1. Sound Systems:
   a. Wide band oscilloscope, 50 MHz, analog. (Example: NTI Audio Minilyzer ML1).
   b. True RMS audio digital volt-ohm-millimeter (Example: Fluke 8060A).
   c. Integrated audio test set (Example: Audio Precision or NTI Audio Minilyzer ML1).
   d. Acoustic polarity tester (Example: NTI Audio Minilyzer ML1).
   e. Pink Noise generator (Example: NTI Audio Digital Audio Signal Generator, Extron VTG 300R).
   f. Calibrated microphone and pre-amplifier assembly (Example: 1/2” ANSI Type 1 ACCO, Larson Davis, Bruel & Kjaer free field incidence capsule, preamplifier/power supply).
   g. Real time audio spectrum analyzer, one-third octave (Example: NTI Audio Acoustilyzer AL1 or Minilyzer ML1, Ivie IE-30A or Rational Acoustics Smaart system).
   h. Frequency/time audio analyzer (Example: Goldline TEF system or Rational Acoustics Smaart system).
2. Baseband Video Systems:
   a. Wide band oscilloscope, 50 MHz, analog. (Example: Tektronix TDS3000C).
   b. Analog composite test generator (Example: Tektronix SPG300).
   c. Analog composite waveform/vector monitor (Example: Tektronix WFM series.)
3. RGBHV Wideband Component Analog Video Systems:

a. Wide band oscilloscope, 500 MHz, analog. (Example: Tektronix TDS3000C).
b. RGBHV test generator (Dot clock 200 MHz, Pixel clock accuracy 100 ppm, Horizontal frequency range 15 kHz to 131 kHz, Vertical frequency range 20 Hz to 120 Hz. (Example: Extron VTG 400D).

4. HD/SDI Video Systems
   a. Pattern & Test Signal Generator (Example: Extron VTG 400D, Tektronix SPG300).
   b. Portable Waveform Monitor/Rasterizer (Examples: Tektronix WFM series, Leader LV5750 with HD/SDI Options)
5. HDMI Video Systems
   a. HDMI EDID Diagnostic (Example: Kramer VA-2H).
6. Projection Systems:
   a. Luminance meter. (Example: Tektronix J17/J18 with J1803 8 degree luminance head.).
   b. Grey scale chart.
   c. Precision optical comparator. (Example: Phillips or Tektronix J17/J18 with J1810/J1820 chromaticity head.).
7. Structured Cabling used for Audiovisual Systems
   a. Level III field testers as defined in ANSI/TIA-1152 - Fluke, Agilent or equal.
      i. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 4 of ANSI/TIA-1152
      ii. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
      iii. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
   b. Tone Test Sets.
8. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.

1.6 SUBMITTALS

A. Conform with Section 27 05 00 - Common Work Results for AudioVisual Systems

1.7 CONFLICTS

A. Present any conflicts between codes, regulations, specifications and/or requirements at least thirty (30) days prior to the commencement of the scheduled work.

1.8 SYSTEM PERFORMANCE REQUIREMENTS, AUDIO-VISUAL SYSTEM

A. Using the listed test equipment, document that the installed systems meet or exceed the performance standards below.

1. Audio Playback and Sound Reinforcement Systems:
   a. Electrical Performance; Source Input to Power Amplifier Output:
      i. Frequency Response (Equalizer flat): +0.5 dB 30 Hz to 15 kHz.
      ii. Total Harmonic Distortion (THD): Less than 0.5%, 30 Hz to 15 kHz, +4 dBm line level.
      iii. Signal to Noise: At least 70 dB, 30 Hz to 15 kHz, referenced to input of +4 dBm.
      iv. Crosstalk: At least -60 dB, 30 Hz to 15 kHz.
   b. Electro/Acoustic Performance:
      i. Standard Classrooms, Coaching Spaces and Conference Rooms
         (1) Uniformity of Coverage:
            (a) Consistent with installed device, location in room and geometric dispersion of sound level.
         (2) Minimum Sound Pressure Level, Pink Noise Input measured on axis to device under test, center of room, at 4 feet above the floor using a freestanding Type 1, microphone:
            (a) Program Audio 80 dB flat weighting, in each octave from 125 Hz to 8 kHz, without clipping.
   c. Equipment: Specified individually.
   d. Audio Signal Path: Shall not degrade performance of connected equipment.
2. Video Systems
   a. Digital performance concurrent with SMPTE 292M HDTV requirements at 1.5 Gigabits.
   b. Analog Composite Video Frequency Response: 100 KHz to 20 MHz within 0.5 dB
   c. Analog Component/RGBHV Video Frequency Response: 100 KHz to 350 MHz within 3.0 dB
   d. Analog NTSC Video Signal to Noise Ratio: at least 65 dB.
   e. Analog RGBHV Video Signal to Noise Ratio: at least 58 dB.
   f. Analog Video Differential Phase and Gain: no more than 0.5 degrees and 0.5 percent, respectively.
   g. Analog and Digital Video Signal to Crosstalk Ratio: at least 50 dB.
   h. Analog Video Timing; no more than .25 degrees variation at 3.58 MHz between any two parallel lines to the same location.
3. Projection Systems:
   a. Consistent with performance of specified projectors and screens.
   b. Brightness, convergence per ANSI standard procedures for device.

B. System Gain/Levels

1. Maintain consistent signal levels throughout the project for each type of signal carried. Patch points shall be unity gain, "flat" equalization, unless specifically noted otherwise

herein or on the drawings. The reference signal levels shall be;

a. Analog Video; 1.0 Volt peak to peak composite signal, sync tip to peak white, defined as "100 IRE", or "100% signal".
b. TV RF; 1000 microVolts, defined as "0 dBmV"
c. Digital Audio, Line Level; -20 dbfs, defined as "0 VU"
d. Analog Audio, Line Level; +4 dBu, defined as "0 VU"
e. Analog Audio, Microphone Level; -50 dBm, 150 ohms
f. Analog Audio, Speaker Level; Greater than +20 dBm
g. Data and Control; As defined by the specification for the signal carried, e.g., RS-232, RS-422 or any other such appropriate standard

C. Masking

1. Masking sound level, following contractor's level and signal equalization
2.

1/3 Octave Band	Sound Pressure Level and maximum permitted variance (dB) below ceiling tile
50 Hz:	47.0 (+4/-6) dB
63 Hz:	47.0 (+4/-5) dB
80 Hz:	47.0 (± 4) dB
100 Hz:	47.0 (± 3) dB
125 Hz:	47.0 (± 3) dB
160 Hz:	46.0 (± 3) dB
200 Hz:	45.0 (± 2) dB
250 Hz:	44.0 (± 2) dB
315 Hz:	42.7 (± 2) dB
400 Hz:	41.3 (± 2) dB
500 Hz:	40.0 (± 2) dB
630 Hz:	38.3 (± 2) dB
800 Hz:	36.7 (± 2) dB
1000 Hz:	35.0 (± 2) dB
1250 Hz:	33.3 (± 2) dB
1600 Hz:	31.7 (± 2) dB
2000 Hz:	30.0 (± 2) dB
2500 Hz:	28.3 (± 2) dB
3150 Hz:	26.7 (± 2) dB
4000 Hz:	25.0 (± 2) dB
5000 Hz:	22.3 (± 2) dB

6300 Hz:	19.7 (± 3) dB
8000 Hz:	17.0 (± 4) dB
10,000 Hz:	12.0 (+4/-6) dB

D. Measurements

1. Contractor to submit quantitative test reports substantiating conformance with the technical performance standards outlined herein above for each cable run, component, subsystem and overall system installed under the work of this Section, concurrent with or prior to identifying to the Owner's Representative that the work is Substantially Complete.
2. Conform with the requirements of Section 27 05 00 – Common Work Results for Audiovisual Systems as to means and method of submittal.

1.9 TRAINING

A. Conduct training on completed system at reasonable convenience of the Owner during normal business hours.

1. Operator Training: 10 hours, including classroom format and hands-on training. Document training using the systems installed under the work of this project. Transmit a copy of the training recordings to the Owner on DVD for subsequent retraining and reference by Owner staff.
2. Initial Use Support: Provide standby trainer/system engineer during one (1) system use, not to exceed 4 hours of supplemental support training.

1.10 DEFINITIONS

A. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:

1. Frequency Response: The minimum acceptable frequency band over which the amplitude response is within 3 dB (or any specified range), or the specified limits of the response relative to the reference frequency (1 kHz for audio, 1.0 MHz for video) under design load conditions, at any operating level up to and including the specified maximum output while fully in compliance with all other performance specifications.
2. Maximum Output Level: The minimum acceptable maximum signal output level (voltage, current or power) attained under design load conditions attained while fully in compliance with all other performance specifications.
3. Harmonic Distortion: The maximum acceptable harmonic distortion measured at any operating level, up to and including the specified maximum output, with an applied sine wave signal of any frequency in the range of the specified frequency response.
4. Audio Intermodulation Distortion: The maximum acceptable intermodulation distortion resulting from the introduction of 60 Hz and 7 kHz signals in a ratio of 4:1 under design load conditions at any operating level up to and including the specified maximum output level.
5. Signal to Noise Ratio: The minimum acceptable ratio of signal to noise levels derived

from broadband measurements under design load at maximum output over the entire range of the specified frequency response.

6. Clipping Level: The minimum acceptable maximum level of signal applied to the device under design load conditions while fully in compliance with all other performance specifications.
7. Sensitivity: The maximum acceptable level of input signal applied to the device that is necessary to provide the maximum output under design load conditions.
8. Design Load: The load (in ohms) specified by usage of the particular device input or output.
9. Composite Triple Beat Ratio: The ratio of visual carrier level to composite third order distortion products.
10. Cross Modulation Ratio: The ratio of visual carrier level to coherent spurious signal level (i.e. intermodulation products).
11. Carrier to Noise Ratio: The ratio of visual carrier to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.

B. Signal Levels: The following voltage levels shall be considered the standard operating levels for the particular circuitry, unless specifically noted otherwise (0.775 Volt = 0 dBu = 0 dbm for a 600 ohms terminated circuit):

1. Microphone Circuits: -30 dBu or less.
2. Audio Line Level Circuits: -30 dBu to +24 dBu; equivalent to -30 dBm to +24 dBm for a 600 ohms terminated circuit.
3. Loudspeaker Level Circuits: More than +24 dBu.
4. Video Line Level Circuits: 1.0 Volt, peak to peak composite signal.
5. Radio Frequency (RF), Television (MATV) Circuits: +6 to +72 dBmV (0 dBmV = 1,000 microvolts).

C. Characteristic Impedances: The following operating impedances shall be considered to be the standard operating impedances for the particular circuitry, unless specifically noted otherwise:

1. Microphone Circuits: 50-250 ohms source, 150-1500 ohms terminating, electrostatically and electromagnetically balanced to ground.
2. Audio Line Level Circuits: 600 ohms maximum source, 600 ohms minimum terminating, line to line, electrostatically and electromagnetically balanced to ground.
3. Video Line Level Circuits: 75 ohms maximum source, 75 ohms minimum terminating to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.
4. Radio Frequency (RF) Television Circuits: 75 ohms nominal to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.

1.11 SOFTWARE LICENSING

A. Provide licensing for project specific software programming at programmable devices.

B. Provide licensing and original software copies for each device provided under Work of this Section that uses software for operation, configuration or control.

1. Provide licensing for required workstation operating systems, and required third party software.
2. For the Control System, provide a complete copy of the source code, including the device interface driver code modules.

C. Upgrade each software package to the release in effect at the end of the Warranty Period.

PART 2 - PRODUCTS

2.1 POWER AMPLIFIERS AND RELATED

A. Power Amplifiers, General

1. Drawing Symbol: PA[number].
2. Provide the following functions and/or features
   a. Employ solid state devices (integrated circuits and/or transistors) throughout and employ positive protection of circuit components.
   b. With amplifier input driven 10 dB beyond input level required to produce full rated output, amplifier shall withstand for at least 15 seconds any of the following load conditions without instability or operation of main over current protection (i.e. no blown fuses or circuit breakers).
      i. "Short" circuit of 0.1 ohm.
      ii. Open circuit (no load).
      iii. Standard Reactive Load: 5.4 ohms in series with the parallel combination of 12.5 microhenrys; 800 microfarads and 18.3 ohms resistive.
   c. Peak voltage of turn-on and/or turn-off transients not greater than 20 dB below maximum rated amplifier output.
      i. Time duration of transients not to exceed 3 seconds.
   d. Input level controls for each output channel to be calibrated, stepped attenuators with at least 50 dB range.
      i. For 0 to 34 dB of attenuation, steps not to be greater than 2.0 dB.
      ii. Attenuators to track calibration within 0.5 dB.
      iii. Stepped attenuators are not required at Power Amplifiers where the connected driving source device includes a precision attenuator under digital control with precision not less than that specified herein.
   e. Input Connectors: XLR connector or tip sleeve (standard) phone jack or barrier strip.
   f. Output Connectors: Standard 0.75 inch spacing "5-way" binding posts, or barrier strip.
   g. Where integral cooling fans are provided, such fans shall have a minimum life rating of 50,000 hours at 25 degree Centigrade ambient temperature.
   h. Where indicated, provide balanced input, differential or transformer. Provide

matching accessory to implement if not a standard feature of the product provided.

i. Listed by a Nationally Recognized Testing Laboratory.

3. Minimum performance requirements with all channels driven

a. Power Output Per Channel: As scheduled on Drawings as Minimum Amplifier (Min Amp) and specified below; continuous average sine wave power into 70 Volt line over a bandwidth of 40 Hz to 20 kHz.

i. Frequency Response: plus 0 dB, minus 0.5 dB, 40 Hz to 20 kHz at rated output.

ii. Total Harmonic Distortion: Less than 0.25 percent at rated output, 40 Hz to 20 kHz.

iii. Intermodulation Distortion: Less than 0.04 percent at rated output using frequencies of 60 Hz and 7 kHz, mixed in a ratio of 4:1.

iv. Input Impedance: 15,000 ohms minimum; unbalanced, or balanced as shown on drawings.

v. Hum & Noise: At least 94 dB signal-to-noise ratio.

vi. Channel Separation: At least 75 dB at 1 kHz.

vii. Phase Shift: Less than plus20 degrees from 20 Hz to 20 kHz.

viii. D.C. Offset: Less than 10 millivolts.

B. Power Amplifiers, 2 Channel, Low Impedance

1. Drawing Symbols

a. PA 25

b. PA100

c. PA200

d. PA300

e. PA400

f. PA800

2. Comply with Power Amplifiers, General, in this Section.

3. Power Output Per Channel, continuous average sine wave power into 8 ohm voice coil impedance, not less than:

a. PA25, 25 Watts

b. PA100, 100 Watts

c. PA200, 200 Watts

d. PA300, 275 Watts

e. PA400, 400 Watts

f. PA800, 650 Watts

4. Dimensions

a. PA 25, not to exceed 1 rack unit for 2 channels.

b. PA100, PA200 and PA300, not to exceed 2 rack units for 2 channels.

5. Manufacturer, PA25

a. Crown D-45

b. Stewart Electronics

c. Or equal

6. Manufacturer, PA100
   a. Crown CL1
   b. Crown Cdi 1000 in low impedance mode.
   c. Stewart Electronics
   d. Electro-Voice
   e. Peavey
   f. Or equal
7. Manufacturer, PA200
   a. Crown CL1
   b. Crown CDi 1000 in low impedance mode.
   c. Stewart Electronics
   d. Electro-Voice
   e. Peavey
   f. Or equal
8. Manufacturer, PA300
   a. Crown CL1
   b. Crown CDi 1000 in low impedance mode.
   c. Stewart Electronics
   d. Electro-Voice
   e. Peavey
   f. Or equal
9. Manufacturer, PA400
   a. Crown CDi 2000
   b. Crest CKV800
   c. QSC CX702
   d. Electro-Voice
   e. or equal
10. Manufacturer, PA800
   a. Two each PA400 as specified herein above.
   b. Crown CDi 4000
   c. QSC CX1102
   d. or equal

2.2 AUDIO PROCESSING

A. Digital Signal Processing (DSP) System

1. Drawing Symbol(s): DSP
2. Function/Features:
   a. Implement functions shown on Drawings using Digital Signal Processing (DSP) hardware and software.
   b. System implements in software at least the following functions as indicated on the plans:

i. AMIX - automatic microphone mixer - MIC and LINE INPUTS as indicated
ii. REMOTE - Remote power on/off, gain control, auxiliary mixer select, System Mode - controlled through interface to Control System specified elsewhere in this Section.
iii. DELAY - multi-channel delay, output quantity as indicated with 0-100 ms delay assignable to each output on selection of delay mode operation.
iv. LEVEL - Gain control under control of REMOTE
v. X02WAY 24dB - Crossover network, 2 port, 24 dB/octave
vi. HP - High Pass Filter
vii. LIM - Limiter
viii. SHELF - Shelving Filter
ix. FBX - Automatic Feedback Suppressor
x. PEQ* - Parametric Equalizer, where * indicates bands provided
xi. MIX* - Mixer, where * indicates channel count
xii. LP - Low pass filter

c. Field reconfigurable functions and parameters.
d. Performance:
   i. Sample at 48 kHz or greater.
   ii. At least 20 bit input/output quantization.
   iii. Noise performance within 3 dB of theoretical limit.
   iv. Minimum of 24 bit internal processing.
   v. Provide control with true status feedback.
e. Priority volume attenuator implemented as indicated on the drawings/specification narrative.

3. Manufacturer - DSP System
   a. Biamp Systems AudiaFLEX configured with Audia IP2 input boards, Audia OP2 output boards and AudiaEXPO output expander as required.
   b. Peavey Electronics MediaMatrix
   c. BSS Soundweb Series
   d. Symetrix SymNet Series
   e. Or equal.

2.3 ASSISTIVE LISTENING SYSTEM (ALS):

A. General
   1. Provide Radio Frequency Type, Frequency Modulated
   2. 72 MHz Assistive Listening band.
   3. Quantity of Devices:

B. ALS Transmitter
   1. Drawing Symbol: ALS TX
   2. Features
      a. Balanced bridging line input.

b. Rack mounted.
c. Connector for remote-mounted antenna.
d. Selectable transmitting frequency.

3. Manufacturer
   a. Listen Technologies LT-800-072 Stationary Transmitter with LA-326 Rack Mounting Kit
   b. Phonic Ear
   c. Williams Sound Corp
   d. Or equal.

C. ALS Remote Transmitting Antenna

1. Drawing Symbol: A
2. Features
   a. Antenna system with mounting hardware, matching specified ALS TX.
3. Manufacturer
   a. Listen Technologies LA-123
   b. Phonic Ear
   c. Williams Sound Corp
   d. Or equal.

D. Receivers and Accessories

1. Receiver
   a. Battery powered, rechargeable.
   b. Volume control.
   c. Receptacle for earphone/accessory.
   d. Rechargeable battery.
   e. Tuneable to channel in use by the user.
   f. Quantity: As Scheduled on the plans
2. Earphone
   a. Ear hung, not inserted in the ear canal.
   b. Hearing-Aid Compatible - For hearing-aid compatible receivers:
   c. Wireless neck loop compatible with “T” coil hearing aids.
   d. Built-in antenna
   e. Operates with provided receivers
3. Manufacturer
   a. Listen Technologies LR-500-072-0-M-C, LA-164 earphones, and LA-166 neck loops
   b. Phonic Ear
   c. Williams Sound Corp
   d. Or equal.

E. Battery Charger/Storage/Carry Case

1. Features
   a. Store and charge up to 16 Receivers and related accessories.
   b. Cover, latches and carrying handles.
   c. Removable lid.
2. Quantity: To simultaneously recharge each received as scheduled on the plans
   a. Manufacturer
   b. Listen Technologies LA-325
   c. Phonic Ear
   d. Williams Sound Corp
   e. Or equal.

2.4 CONTROL SYSTEM, SWITCHING AND RELATED

A. General

1. Products provide under this Section shall be made by manufacturers regularly engaged in the production of programmable commercial audio-visual control systems. Such manufacturers shall have at least 5 years prior production experience in the manufacture of such goods.
2. Provide control system to perform functions scheduled on drawings and herein.
   a. System to be field programmable.
   b. Provide programming allowance to implement system as required to provide the functionality indicated herein and as defined by the Owner during design and construction phase meetings, including closely matching the user interface of the existing control panels used elsewhere at the Owner in style, color and organization to the extent directed by the Owner's Representative.
3. In addition to providing programming to meet the requirements outlined in part one of this specification section and as outlined by the Owner during the reconstruction programming meetings, contractor to provide an allowance of up to $6000 to implement new functions in the audiovisual systems programming identified by the Owner after the substantial completion of this project. Allowance may not be expended by the Contractor in completing the base bid scope of work including warranty defect items.

B. Control Processor

1. Drawing References:
   a. Control3
   b. CBlock
   c. Control PS - A/V Net power supply
2. Features/Functions/Performance:
   a. Control System shall utilize a processor at no less that of sufficient capacity to provide the indicated control functions without degradation due to system overload.
   b. I/O Ports:
      i. At least 3 RS-232/422/485 Ports.
      ii. At least 8 IR/Serial Ports.

iii. At least 8 Isolated Relay Ports
iv. At least 8 I/O Ports.
v. At least 1 Port for the control system manufacturer's proprietary A/V network.
vi. At least 1 TCP/IP Ethernet Network connection via an RJ-45 connector.

c. Control System shall be fully compatible with the control system manufacturer's projector and A/V equipment status monitoring and
d. management software.
e. Control System shall include a 10/100 BaseT Ethernet Port that supports
f. all of the following features:
   i. TCP/IP Communications
   ii. DHCP and DNS Support
   iii. IEEE 802.11b and Bluetooth Compatibility
   iv. Native Email Client
   v. Remote Diagnostics
   vi. Remote Program Loading and Administration
   vii. Built-In Web Server
   viii. FAT32 File System for easy data management
   ix. SSL security plug-in
   x. PDA Integration and Control, XPanel PDA - Pocket PC 2002
   xi. WebTablet Integration and Control – Microsoft Tablet PC
   xii. Self Generating Executable GUI, XPanel EXE – Microsoft Family of Operating Systems
   xiii. Self Generating ActiveX powered Microsoft Internet Explorer Integration and Control, XPanel Microsoft Internet Explorer.
   xiv. Self Generating Java powered Web Integration and Control
g. Control System Processor shall utilize a real time, event driven, multitasking, multi-threaded operating system with a dual bus architecture.
h. High speed processor shall communicate directly with Ethernet, control
i. ports and proprietary control network utilizing high-speed, parallel bus
j. infrastructure. Control processors that communicate via a serial bus shall
k. not be accepted.
l. Control processor shall contain sufficient memory for the applications indicated.
m. Control System processor shall utilize a FAT32 file structure.
n. Control System shall support internal communications speed via two, independent communications busses. First control bus speed shall be at least 40 mb/s, second control bus speed shall be at least 300 mb/s.
o. Full API (Applications Interface) directly to control system via TCP/IP for integration with Visual Basic, C++, Java, etc. applications. API support through included control system manufacturer's ActiveX modules and/or their Dynamic Link Library (.DLL) file.
p. Control system manufacturer's to continuously monitor the integrity of the A/V control network for wiring faults, marginal communication
q. performance, network errors – all information is viewable.

r. System Support RS-485 token passing network with data communication for a minimum distance of 5000 feet.
s. Allow proprietary A/V Network network expansion via Ethernet or RS-232 ports, which can allow for high-speed network acceleration.
t. Support a minimum of 253 proprietary network devices simultaneously.
u. Control system shall support object-oriented logic based programming
v. language and a C-like language programming language. Both programming types are supported to run simultaneously and integral to
w. each other.
x. System shall supply Windows-based graphical
y. programming software for drag and drop object oriented programming for the control system operation.
z. System shall provide Windows-based graphical programming software, which is self-documenting in that it generates a symbolic flow diagram printout from the system program.
aa. The control system shall support a variety of wireless communication modes, including one-way and two-way radio frequency and infrared transmission.

3. Provide supplemental AV Network power supplies and network segmentation (C Block) as necessary to conform with the manufacturer's recommendations for the total number of connected devices.
4. Manufacturers:
   a. Crestron Series 3 or CP2E with I/O expanders as required to match indicated functionality, CNTBLOCK and CNPWS-75 power supplies as required. Provide options and software kit as necessary to enable manufacturers XPanel IE functionality at clinicians desktops, and at desktop of of designated clinical lab administrative support personnel.
   b. AMX
   c. Extron
   d. or equal.

C. A/V Net distribution block

1. Drawing Reference: CBLOCK
2. Function/Features/Performance:
   a. Parallel distribution block for termination of multiple 4-wire A/V net cables
   b. NET 1 – 8: (8) 4-pin 3.5mm detachable terminal blocks
   c. Enclosure: Steel, black matte powder coat finish, surface mount box with (2) integral mounting flanges
3. Manufacturers
   a. Crestron CNTBLOCK
   b. Extron
   c. AMX
   d. Or equal.

D. Control Panels, Touch, 9” Diagonal

1. Drawing Reference: CTP9
2. Features/Functions
   a. Touchscreen Display
      i. Display Type TFT Active matrix color LCD
      ii. Size 9 inch (229 mm) diagonal
      iii. Aspect Ratio 15:9 WVGA
      iv. Resolution 800 x 480 pixels
      v. Brightness 350 nits (cd/m²)
      vi. Contrast 700:1
      vii. Color Depth 24-bit, 16.7M color
      viii. Illumination Edgelit fluorescent
      ix. Viewing Angle ±88° horizontal, ±88° vertical
      x. Touchscreen Resistive membrane
   b. Graphics Engine 16-bit non-palette graphics; 65,536 colors; multi-mode objects; dynamic graphics and text; PNG translucency; full-motion (60 fps) animation; transition effects; color key video windowing
   c. Communications
      i. Ethernet 10BaseT/100BaseTX, auto-switching, auto-negotiating, auto-discovery, full/half duplex, TCP/IP, UDP/IP, CIP, DHCP, for control and console
      ii. Control AV Net slave mode for control and console. Provide with manufacturer's standard terminal jack and wall plate connector combinations at locations indicated for CN terminations to enable device to be relocated as required.
      iii. USB USB 1.1 client for console
   d. Enclosure
      i. Plastic 0° to 45° adjustable tilt mechanism, low-profile base, integral 10 ft (3 m) cable assembly
      ii. 8”H x 11”W x 7”D
      iii. Submit color choice for selection by City representative.
3. Manufacturers
   a. Crestron
   b. Extron
   c. AMX
   d. Or equal.

E. 100Base-T Layer 2 Edge Switch

1. Drawing References: 100 ESW
2. Port Count:
   a. As Required plus at least 3 spare
3. Features/Functions/Performance:
   a. RJ-45 10/100Base-TX ports (IEEE 802.3 Type 10Base-T; 802.3u Type 100Base-TX) ports.

b. Each port can automatically provide 10 or 100 MBps Ethernet Layer 2 switching.
c. Each port can automatically sense maximum connection speed of attached device (10 or 100 MBps) and its ability to support full or half duplex connectivity and respond (auto-sensing). .
d. Performance - at least:
   i. throughput: 1 million pps (64-byte packets)
   ii. address table size: 2,000 entries
e. Communications - provides full support for the following standards:
   i. IEEE 802.1p Priority;
   ii. IEEE 802.1D Spanning Tree;
   iii. IEEE 802.1Q VLANs;
   iv. IEEE 802.3x Flow Control
f. Management - Provide at least:
   i. SNMPv1/v2c
g. Environmental - can operate normally within at the following range of conditions:
   i. operating temperature: 0 degrees C to 55 degrees C (32 degrees F to 131 degrees F)
   ii. relative humidity: 15 to 95% @ 40 degrees C (104 degrees F), non-condensing
h. Provides port filtering by MAC address.
i. Automatic shutdown of ports detecting jabber
j. Status lights indicating at least port activity on each port.

4. Construction.
   a. 1 Rack Unit maximum per 12 ports provided.
   b. Provide accessories as required to rack mount.
5. Manufacturers:
   a. Netgear
   b. DLink
   c. Hewlett Packard
   d. Cisco Systems
   e. or equal.

F. Control Panel with integral processor and serial port, Hardwired, Module Style

1. Drawing References: CBP1
2. Features:
   a. Wall mount pushbutton control panel
   b. Programmable buttons to accommodate control of a device's:
      i. Power On and Off
      ii. Volume Up and Down
      iii. Source Select Toggle
         (1) Multiple pushes of a single button switches between controlled device's input sources

c. Communication: RS232
d. 1-gang, Decora wall-mountable

3. Manufacturer:
   a. SP Controls PixiePlus PXE-DCM+
   b. Crestron BPC-8
   c. RTI
   d. or equal

2.5 VIDEO PROCESSING

A. HDMI Routing Switcher, with Signal Transport and Up-Conversion

1. Drawing References: HSW8x8, HSW16x16, HSW32x32, WPI, WPIH, WPIHS, HCAT RPTR, HCMPO, HCMPOF, HCMPOA.
   a. At HSW Switchers the designation IxO, where I is 8, 16 or 32 and O is 8, 16, 32, the values of I and O indicate the minimum number of input and output ports to be provided respectively.
2. General
   a. Provide and install as indicated on the drawing an HD Content Point-to-Point Transport System.
   b. The HD Digital Transport and Distribution System shall include providing and integrating the following principal systems:
      i. Audio/Video switching.
      ii. Audio/Video distribution at native resolution without compression.
      iii. Video interface equipment.
      iv. Audio interface equipment.
      v. HDMI signal transport.
      vi. HDMI 1.3 support.
      vii. Deep Color support.
      viii. Resolution management.
      ix. HDCP key handling/management.
      x. EDID management.
      xi. Fast HDMI switching with keep alive HDCP link.
      xii. Multi-Channel Surround Sound Audio.
      xiii. Digital diagnostic tools
   c. Audio & Video Switching
      i. The AV switching system shall support at least 6.75Gbps of data transfer on each input and output to support 1080p 36-bit (Deep) Color video resolutions without compression.
      ii. The AV switching system shall support 8 channel audio.
      iii. The AV switching system shall support audio breakaway from video.
      iv. The AV switching system shall have less than 5us of latency from AV input to AV output.
      v. The AV switching system shall support the HDMI specification of less than 1 in 1x10-9 bit errors at 1080p 36-bit (Deep) Color.

vi. The AV switching system shall downmix multi-channel audio into 2-channel audio so that the same audio content may be routed to both multi-channel and 2-channel sinks.

vii. The AV switching system shall be able to dither between standard and deep color video signals on each input and output.

viii. The AV switching system shall support the following AV signal inputs:

(1) HDMI 1.3a (High Definition MultiMedia Interface)

(2) DVI 1.1 (Digital Visual Interface)

(3) DisplayPort Multimode 1.1

(4) Analog RGB

(5) YPbPr

(6) S-Video

(7) CVBS

(8) SPDIF

(9) Analog Stereo Audio

ix. The AV switching system shall transcode the AV signals to a single signal type for distribution.

d. Audio Video Distribution

i. The AV distribution system shall use multimode fiber or shielded twisted pair for AV signal distribution.

ii. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

iii. The twisted pair structured cabling used to carry the AV signals shall be shielded.

iv. The twisted pair structured cabling used to carry the AV signals shall be specified to 1.2GHz of bandwidth or greater.

v. The AV distribution system shall not require extra cabling to transmit the following control signals for AV sources and sinks:

(1) RS-232

(2) Infrared

(3) Ethernet

(4) USB Human Interface Device-class devices

(5) Contact closure

e. EDID Management
   i. The AV switching system shall allow configuration of the EDID presented to sources on each AV input.
   ii. Each input on the AV switching system shall be configured independently.
   iii. The AV switching system shall by default present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
   iv. The AV switching system shall allow the user to enter each input's EDID video timings individually.
   v. The AV switching system shall allow the user to enable and disable support for the following items in each input's EDID.
      (1) Deep color
      (2) 3D support
f. HDCP Management
   i. The AV switching system shall support HDCP 1.1 or greater.
   ii. The AV switching system shall detect the number of KSVs supported by each source. A KSV is commonly called an HDCP 'key'. A unique ID for each HDMI sink that must be sent to HDCP-enabled sources in order for the sinks to receive content.
   iii. The AV switching system shall not send a source more KSVs than it supports.
   iv. The AV switching system shall cache the KSVs from each connected sink.
   v. The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.
g. Signal Detection
   i. The AV switching system shall report the following incoming signal information to an AV control system:
      (1) Signal detect
      (2) Horizontal and vertical resolution
      (3) Signal refresh rate
      (4) Presence of HDCP
   ii. The AV switching system shall report the following information to an AV control system:
      (1) HDCP authentication status for each source and sink
      (2) EDID Preferred video timing for each sink
      (3) Maximum number of KSVs supported by each source
h. Troubleshooting
   i. The AV switching system shall report the following information for troubleshooting:
      (1) Maximum number of KSVs supported by each source
      (2) The number of KSVs sent to each source
      (3) EDID indicated Video timings and audio formats supported for each sink
      (4) EDID presented to each source

ii. The AV switching system shall support off-site remote troubleshooting via Ethernet

i. HD Digital Transport and Distribution System

i. The HD Digital Transport and Distribution System operate as part of a larger matrix switching system.

ii. HD Source/Sink Controller

(1) The HD Source/Sink Controller shall provide control of connected devices (i.e. Blu-Ray Players, LCD Monitors, Projectors, etc.) when used in conjunction with an AV Network Control System. It shall support IR and RS-232/422/485 protocols, closed-contact input, low-voltage relay, and HDMI CEC (Consumer Electronics Control). No additional cabling (above the required cabling for the HD Digital Transport and Distribution System) shall be required.

iii. The HD Content Transport System shall be an advanced signal extender system incorporating the following features:

(1) HD Content Transmitter.

(2) HD Content Receiver.

(3) UTP/STP or Fiber Optic cabling.

(4) HDCP 1.1 support.

(5) Fast HDMI switching.

(6) CEC support.

(7) Uncompressed video and audio transport.

(8) HDMI 1.3 with Deep Color.

(9) 7.1 channel HD lossless audio.

(10) Video resolutions up to 1920x1200 or 1080p/60.

(11) Advanced video detection on every video type, including resolution, frame rate and color depth.

(12) IR and RS-232 control over local device(s) (when used with a control system by same manufacturer).

(13) Ethernet support.

(14) Signal transmission up to 450 feet via UTP/STP cable.

(15) Signal transmission up to 3000 feet via fiber.

j. Transmitters

i. The HDMI Transmitters shall be able to extend HDMI (including audio) . Where two or more signal inputs are available, the transmitter shall include integrated switcher with signal sensing. The switcher shall switch to the last detected input (when not used with a control system by the same manufacturer). The HDMI transmitter types shall be as follows:

ii. Transmitter Type WPI

(1) The WPI signal transmitters shall extend HDMI video, audio, and data over a single UTP/STP cable to compatible transmission receiver modules or ports. The following source formats shall be supported:

(a) HDMI

(b) DVI-I

(c) RGBHV
(d) VGA
(e) YPbPr
(f) Y/C
(g) Composite
(h) Analog 2-channel audio
(i) USB HID (Human Interface Device)

(2) Performance. The transmitter shall meet the following minimum requirements:
(a) One (1) HDMI video, audio, and control input:
(b) Supports HDMI.
(c) Supports HDCP.
(d) Supports Dolby Digital, Dolby Digital EX, DTS, DTS-ES, DTS 96/24, up to 8 channel PCM.
(e) Supports DVI-D with adaptor.
(f) Supports DisplayPort Multimode.
(g) CEC device control.
(h) One (1) DB15 input:
(i) Component (YPbPr)
(j) RGB
(k) S-Video (Y/C)
(l) Composite Video
(m) One (1) analog stereo audio input:
(n) (1) 3.5mm TRS (L/R unbalanced)
(o) One (1) USB HID port.
(p) Supports USB HID class devices

(3) Single UTP/STP cable transmission connection
(a) Supports HDBaseT signal specifications.
(b) Supports remote power injection through matrix switcher.
(c) Supports CAT5e.

(4) Signal transmission up to 330 feet.

(5) Power supply modes:
(a) Remote power supplied by matrix switcher through UTP/STP transmission cable.
(b) Local or remote DC power source.

(6) Mounting:
(a) 2-gang wall box mount.
(b) 2-gang floor box mount.

iii. Transmitter/Receiver Type WPIS
(1) HDMI transmission, as for WPI
(2) RS-232 transmission through use of matched transmitter receiver pairs.
(3) Signal transmission up to 330 feet.
(4) Mounting:

(a) 1-gang box mount.

iv. Transmitter Type WPIH

(1) HDMI transmission, as for WPI

(2) Signal transmission up to 330 feet.

(3) Mounting:

(a) 1-gang box mount.

k. Receivers, Fiber

i. The receiver shall accept the HD signal via multimode fiber and convert it to one (1) HDMI output. When used with a supported control system, the receiver shall provide local control to device(s). In addition, when used with the Matrix switcher, the receiver shall provide Ethernet connectivity to any compatible devices.

ii. The receiver shall meet the following minimum requirements:

(1) HDMI 1.3 digital video/audio output.

(2) One (1) 19-pin Type A HDMI female connector.

(3) One (1) USB 1.1 port for USB HID data.

(4) Mouse, keyboard, game controller, or other USB HID device support.

(5) USB Type A female connector.

(6) Two (2) relays.

(a) 4-pin 3.5mm detachable terminal block comprising (2) normally open, isolated relays.

(b) Rated 1 Amp, 30 Volts AC/DC.

(c) MOV arc suppression across contacts.

(7) One (1) bidirectional RS-232 port.

(a) One (1) 5-pin 3.5mm detachable terminal block.

(b) GND, TX, RX, CTS, RTS support.

(c) Up to 115.2k baud, hardware and software handshaking support.

(8) Two (2) IR/Serial ports.

(a) One (1) 4-pin 3.5mm detachable terminal block.

(b) IR output up to 1.1 MHz.

(9) 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.

(10) One (1) Digital/contact closure sensing input.

(a) One (1) 2-pin 3.5mm detachable terminal block

(b) Rated for 0-24 Volts DC, referenced to GND;

(c) Input Impedance: 2.2k ohms pulled up to 5 Volts DC;

(d) Logic Threshold: 2.5 Volts DC nominal with 1 Volt hysteresis band.

(11) One (1) 10/100 LAN port.

(12) One (1) Fiber input.

(13) Two (2) multi-mode fiber inputs.

(14) Two (2) SC multimode fiber connectors.

(15) One (1) power input.

(16) (1) 2-pin 3.5mm detachable terminal block.

(17) Shall support transmission distances of up to 1000ft.

(18) Flush mountable to a 2-gang, 4" square, or Euro electrical box.

iii. Receivers, Copper with Scaler

(1) The signal receiver shall receive long distance transmission from compatible transmitter modules or ports. Receiver shall include the following outputs types and connections:

(a) HDMI

(b) USB HID (Human Interface Device)

(2) Receiver shall include the following control port types for remote device control.

(a) Serial RS-232 communication.

(b) Infrared (IR) control.

(3) Performance

(a) The receiver shall meet the following minimum requirements:

(b) HDMI digital video, audio, and control output:

(c) One (1) 19-pin Type A HDMI female connector

(d) Supports HDMI with Deep Color and 3D.

(e) Supports DVI-D with adaptor.

(f) Supports HDCP.

(g) HDMI audio Support:

(h) Dolby Digital, Dolby Digital EX, Dolby TrueHD, DTS, DTS-ES, DTS 96/24, DTS-HD Master Audio, and up to 8 channel PCM.

(i) CEC device control.

(4) Integrated HD video scaling:

(a) Deinterlacing and interlacing.

(b) Frame rate conversion.

(c) Deep Color support.

(d) 3D to 2D conversion.

(e) Content adaptive noise reduction.

(f) Wide screen format selection:

(g) Zoom.

(h) Stretch.

(i) Maintain source aspect ratio.

(j) 1:1.

(5) One (1) bidirectional RS-232 port:

(a) One (1) 5-pin 3.5mm detachable terminal block.

(b) GND, TX, RX, CTS, RTS support.

(c) Up to 115.2k baud, hardware and software handshaking support.

(6) Two (2) IR/Serial ports:

(a) One (1) 4-pin 3.5mm detachable terminal block.

(b) IR output up to 1.1 MHz.

(c) 1-way serial TTL/RS-232 (0-5 Volts) up to 19200 baud.

(7) One (1) USB HID port.

(a) USB type A female.

(8) One (1) 10/100 LAN port.
(a) Single UTP/STP cable transmission connection
(b) Supports HDBaseT signal specifications.
(c) Supports CAT5e
(d) Signal transmission up to 330 feet
(9) Power supply:
(a) Local or remote DC power source.
(b) Mounts on a US 2-gang electrical box

l. HD Content Matrix Switcher
i. The HDMI Matrix shall consist of a card-cage type unit, capable of accepting different input and output cards.
Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.
ii. The HDMI Matrix shall be compatible with the HD Content Point-to-Point Transport System.
iii. The matrix shall meet the following minimum requirements:
(1) Ethernet support.
(a) Gigabit uplink.
(b) Integrated 10/100 managed Ethernet switch.
(2) Eight, Sixteen or 32 field configurable input card slots corresponding to indicated input configuration
(3) Two, Four or Eight output card slots, where output card accommodates 4 signal outputs to provide eight, 16 or 32 outputs where indicated by inidcated output configuration.
(4) Software based setup tool.
(5) Front panel LCD diagnostic screen.
(6) HDCP key register detection.
(7) HDMI Cable test tool.
(8) Automatic resolution management via EDID.
(9) HDCP digital rights key management.
(10) Fast HDMI switching with keep-alive HDCP link.
(11) CEC signal management.
(12) Intercept CEC data being sent from HDMI devices.
(13) Forwards AV control network information.
iv. Input Cards
(1) Input cards shall accept various signal types. Input signals shall be converted to HDMI format.
(2) HDMI Input Cards
(a) The HDMI input cards shall be compatible with the HDMI Matrix. Input cards shall provide HDMI (connector) buffered output of input signal. Input cards shall be field upgradeable/installable.

(b) The HDMI input card shall accept an HDMI signal. This signal shall be available as an output on the matrix.

(c) The HDMI input card shall meet the following minimum requirements:

(d) One (1) HDMI input.

(e) 19-pin type A female HDMI connector.

(f) Supports HDCP 1.1.

(g) Supports HDMI 1.3 with Deep Color.

(h) One (1) HDMI output.

(i) Buffered output from input.

(j) 19-pin type A female HDMI connector.

(k) Supports HDCP 1.1.

(l) Supports HDMI 1.3 with Deep Color.

(m) One (1) USB 1.1 port for USB HID data.

(n) Mouse, keyboard, game controller, or other USB HID device support.

(o) USB Type A female connector.

(p) Digital to analog converter.

(q) 24-bit, 48 KHz

(r) One (1) stereo analog audio output.

(s) Two (2) RCA female connectors.

(t) Unbalanced line-level output.

(u) Provides pass-through signal converted from HDMI input.

(v) Maximum Output Level: 2 Vrms.

(w) Output Impedance: 100 ohms nominal.

(x) Analog shall meet or exceed:

(y) Frequency response: 20Hz to 20kHZ ±0.5dB.

(z) S/N Ratio: >95dB, 20Hz to 20kHz A-weighted;

(aa) THD+N: <0.005% @ 1kHz;

(bb) Stereo Separation: >90dB

(3) DVI Input Card

(a) The Video Input Card shall accept a DVI video signal, injected audio and convert to HDMI signal. This signal shall be available as an output on the matrix.

(b) The HDMI input card shall meet the following minimum requirements:

(c) One (1) DVI input.

(d) One (1) DVI-I female connector.

(e) Auto-sensing multi-format analog video input.

(f) Support for the following video types:

(g) DVI

(h) YPbPr (component).

(i) Y/C (S-Video).

(j) RGB

(k) Support for the following video formats:

(l) NTSC

(m) PAL
(n) Support for the following video resolutions:
(o) 480i
(p) 480p
(q) 576i
(r) 576p
(s) 720p
(t) 1080i
(u) 1080p
(v) Video analog to digital converter.
(w) 10-bit, 170MHz.
(x) One (1) HDMI output.
(y) Buffered output from input.
(z) 19-pin type A female HDMI connector.
(aa) Pass through of video input signal (matched format/resolution).
(bb) Pass through of audio input signal.
(cc) One (1) analog audio input.
(dd) One (1) 5 pin 3.5mm terminal block- detachable.
(ee) Pass through to HDMI output.
(4) UTP/STP Input Card
(a) The UTP/STP Input Card shall accept UTP/STP signal and convert to HDMI signal and separate audio output. This signal shall be available as an output on the matrix.
(b) The UTP/STP input card shall meet the following minimum requirements:
(c) One (1) UTP/STP input.
(d) Two (2) 8 pin RJ45 UTP/STP connectors, female.
(e) Support for the following video resolutions:
(f) 480i
(g) 480p
(h) 576i
(i) 576p
(j) 720p
(k) 1080i
(l) 1080p
(m) Video analog to digital converter.
(n) 10-bit, 170MHz.
(o) One (1) HDMI output.
(p) Buffered output from input.
(q) 19-pin type A female HDMI connector.
(r) Pass through of video input signal (matched format/resolution).
(s) Support for various audio/surround formats:
(t) Bypass.

(u) Stereo.
(v) PCM 96/24.
(w) MLP Lossless.
(x) Dolby Pro Logic IIx.
(y) Dolby Digital 5.1.
(z) Dolby Digital EX.
(aa) Dolby TrueHD.
(bb) DTS Neo:6.
(cc) DTS Virtual.
(dd) DTS Digital 5.1 Discrete.
(ee) DTS ES 6.1 Discrete.
(ff) DTS ES 6.1 Matix.
(gg) DTS 96/24.
(hh) DTS-HD Master Audio.

(ii) Pass through of audio input signal.
(jj) One (1) analog audio ouput.
(kk) Two (2) RCA female connectors.
(ll) Pass through to HDMI output.
(mm) Digital to analog conversion 24 bit 48 kHz

v. Ouput Cards

(1) The HDMI output cards shall be compatible with the HDMI Matrix. Output cards shall transmit any input signal. Output cards shall have various arrangements of connector types. Output cards shall have up to four (4) outputs per card. Output card types shall be as follows:

(2) UTP/STP Output Card

(a) The UTP/STP Output Card shall provide transmission of any HDMI signal inputted to the matrix.
(b) The Output Card shall provide four (4) discrete outputs.
(c) The Output Card shall interface with unshielded twisted-pair or shielded twisted pair cable.

(3) HDMI Output Card

(a) The HDMI Output Card shall provide transmission of any HDMI signal inputted to the matrix.
(b) The Output Card shall provide four (4) discrete outputs.
(c) The Output Card shall interface with 19-pin Type A HDMI female connectors.

m. Minimum Environmental Operating Conditions
   i. Temperature: 32° to 104°F (0° to 40°C)
   ii. Humidity: 10% to 90% RH (non-condensing)
   iii. Heat Dissipation: 1500 BTU/Hr
n. Enclosure
   i. Chassis: Metal with black finish, vented sides, fan-cooled
   ii. Faceplate: Extruded aluminum, black finish with polycarbonate label overlay
   iii. Mounting: 7U 19-inch rack-mountable rack ears included)
o. Dimensions
   i. Height: 12.22 in (311 mm) without feet
   ii. Width: 17.28 in (439 mm), 19.00 in (483 mm) with ears
   iii. Depth: 18.13 in (461 mm) without cards

3. Manufacturers:
   a. Crestron
      i. HSW8x8: DM-MD8X8 DigitalMedia Switcher with input cards as required, including DMC-F-DSP, DMC-HD-DSP, DMC-DVI, DMC-CAT, and 8G output cards in quantities as required to provide the indicated functionality.
      ii. HCMPO: DM-RMC-SCALER-C.
      iii. HCMPOA: DM-RMC-200-C
      iv. HCMPOF: DMC-150-S
      v. HCAT RPTR: DM DR
      vi. WPI: DM-TX-200-C-2G Wall Plate DigitalMedia CAT Transmitter in quantities as required to provide the indicated functionality.
      vii. WPIS: HD-TX3-C and HD-RX3-C. Provide in pairs.
      viii. WPIH: DM-TX-1G
      ix. Provide MP-WP185 Media Presentation Wall Plate at floor box and similar locations where cable needs to be connectorized.
      x. Adapter Cabling as required.
   b. Extron
   c. AMX/Autopatch
   d. or equal

2.6 SOURCE DEVICES

A. Microphone, Gooseneck, Desk, with Switch

1. Drawings Reference: Keynote call-out, GMIC
2. Function/Features/Performance
   a. Gooseneck integrated microphone with desktop base with integrated programmable switch and indicator.
   b. Element: Cardioid condenser.
   c. Frequency response: +/- 3 dB, 80 Hz to 15,000 Hz
   d. Output impedance 200 Ohms or less.
   e. Total harmonic distortion: Less than 3% at 110 dB SPL.

f. Output level (Open circuit Voltage at 1,000 Hz): at least -78.0 dB (0dB= 1 V/microbar).
g. Maximum SPL: 120 dB.
h. Signal to noise ratio: 65 dB at 1 kHz at 94 dB SPL.
i. Power: Phantom (Simplex) 12 to 48 VDC operating range.
j. Windscreen: Foam or metal and foam.
k. Gooseneck: Flexible, miniature. Stiff center section, flexible both ends.
l. LED indicator: On when microphone is on.
m. Connector: 5 pin circular audio connector, male, on 10 foot cable.
n. Finish: Flat black.
o. Length: Approximately 18 inches overall
p. Base: Weighted desktop base.
q. Switch: Membrane switch, programmable function. Configure for push on/push off function.

3. Manufacturer
   a. Shure MX418D/C and accessory mic cable (black).
   b. AudioTechnica ES915C18 Gooseneck Microphone with AT8666RSC Base and accessory mic cable (black).
   c. Or equal.

B. Radio Frequency Receiver/Wireless Microphone System:

1. Drawing Reference(s):
   a. WMRX
   b. WMIC LAV - Wireless Mic, Lavalier
   c. Wireless microphone symbol.
2. Provide quantity of complete systems to match quantity of WMIC LAV microphone symbols shown.
   a. Coordinate operating frequency with other UHF local sources, including but not limited to current television operating frequencies and DTV frequency allocations and/or local pubic safety operating frequencies to eliminate any interference from outside RF sources.
   b. Provide Receiver unit configured for diversity reception.
   c. Allows the expansion of wireless microphone systems by splitting one pair of antennas to multiple receivers. It also amplifies RF signals to compensate for insertion loss that results from splitting signal power to multiple outputs. A single system can support up to four wireless receivers.
3. Function/Features/Performance:
   a. WMRX/WMIC LAV
      i. Operating Range Under Typical Conditions: 100m (300 ft.) Note: actual range depends on RF signal absorption, reflection, and interference.
      ii. Audio Frequency Response (+/– 2 dB): Minimum: 45 Hz; Maximum: 15 kHz
      iii. Total Harmonic Distortion (ref. +/– 38 kHz deviation, 1 kHz tone): 0.5%, typical
      iv. Dynamic Range: >100 dB A-weighted

v. Operating Temperature Range: –18°C (0°F) to +57°C (+135°F)
Note: battery characteristics may limit this range

vi. Transmitter Audio Polarity: Positive pressure on microphone diaphragm (or positive voltage applied to tip of WA302 phone plug) produces positive voltage on pin 2 (with respect to pin 3 of low impedance output) and the tip of the high impedance 1/4-inch output.

4. Manufacturer, WMIC LAV System:
   a. Shure SLX14/85 Lavalier Wireless System and SLX1 Body Pack with carrying case and SLX4 Diversity Receiver
   b. Telex
   c. Audio Technica
   d. Sennheiser
   e. Or equal.

C. 4x HDMI Distribution Amplifier.

1. Drawing Reference: “HDMI 1x4”
2. Video Input Signal Types HDMI®, DVI[1], DisplayPort Multimode[1].
3. Output Signal Types HDMI, DVI[1]
4. Formats HDMI w/Deep Color, 3D, & 4K; DVI; HDCP content protection support.
5. Audio Formats: Dolby Digital®, Dolby Digital EX, Dolby Digital Plus, Dolby® TrueHD, DTS®, DTS-ES, DTS 96/24, DTS-HD High Res, DTS-HD Master Audio™, up to 8ch PCM.
6. Audio Input Signal Types HDMI, DisplayPort Multimode[1], Output Signal Type HDMI.
7. Communications: HDMI HDCP & EDID (does not pass CEC); EDID Mode selectable for COPY 1ST or DEFAULT: COPY IST copies the EDID from the device connected to OUTPUT 1 and sends it to the source connected to the INPUT[3]; DEFAULT = 720x480@60Hz, 1280x720@60Hz, 1920x1080@30Hz, 1920x1080@60Hz (preferred), and 2-channel linear PCM audio).
8. Connectors INPUT (1) 19-pin Type A HDMI female; HDMI digital video/audio input; Also supports DVI and DisplayPort Multimode[1]; OUTPUT 1 – 4 (4) 19-pin Type A HDMI female; HDMI digital video/audio outputs; Also supports DVI[1].
9. Maximum Resolutions/Scan Type/Maximum Resolution/Frame Rate/Color Sampling:
   a. Progressive 4096x2160 4K DCI Up to 24 Hz 4:4:4
   b. Progressive 3840x2160 Ultra HD Up to 30 Hz 4:4:4
   c. Progressive 2560x1600 WQXGA Up to 60 Hz 4:4:4
   d. Progressive 4096x2160 4K DCI Up to 60 Hz 4:2:0 [2]
   e. Progressive 3840x2160 Ultra HD Up to 60 Hz 4:2:0 [2]
   f. Interlaced 1920x1080 1080i30 Up to 30 Hz 4:4:4
   g. (NOTE: Common resolutions are shown; other custom resolutions are supported at pixel clock rates up to 300 MHz).
   h. Formats HDMI w/Deep Color, 3D, & 4K; DVI; HDCP content protection

support.

10. Manufacturers
    a. Crestron HD-DA-4K-E w/ PW-2407WU 24 volt power pack.
    b. Or equal.

D. High Definition A/V Transmitter

1. Drawing Reference: DMTX
2. Functions/Features:
    a. Provides HDMI, RGBHV and mini stereo audio inputs
    b. Provides USB extension
    c. Provides LAN connectivity
    d. Transmits audio, video and control signaling to specified receiver over a single UTP6-4P cable.
    e. HDCP compatible.
    f. Can be remotely powered by specified control system.
    g. Mounts to underside of table.
    h. Nominal dimensions: 6.5” x 7” x 1.5”
3. Manufacturer
    a. Crestron DM-TX-201-C
    b. Or equal.

E. HDMI and RGBHV w/ Stereo Audio Input Plate

1. Drawing Reference: MP1
2. Features/Functions
    a. Inputs
        i. HDMI
        ii. RGBHV
        iii. Stereo Audio
        iv. USB
    b. 2x1 combination digital/analog switch
    c. Supports resolutions up to 2048x1080 @ 24Hz
    d. Analog-To-Digital Conversion 10-bit 165 MHz per each of 3 channels
    e. Communications
        i. Audio, video and control 330 feet over a single UTP Cat 6 cable.
        ii. HDCP management, EDID format management, CEC
    f. USB Supports USB HID class devices
    g. Compatible with specified switcher.
    h. Remotely powered from switcher/headend equipment location.
    i. 2 gang.
3. Manufacturers
    a. Crestron DM-TX-200-C-2G w/ required remote power accessories.
    b. Extron

c. Or equal.

F. Multimedia Receiver w/ Scaler

1. Drawing Reference: DMRX
2. Features/Functions
   a. Receives audio, video and control over a single UTP Cat 6 cable.
   b. Outputs
      i. HDMI, DVI
      ii. RS-232
      iii. IR
      iv. USB
      v. LAN
   c. Communications: HDCP management, EDID format management, CEC
   d. Supports resolutions up to 2048x1080 @ 24Hz
   e. Compatible with specified switcher.
   f. Enclosure
      i. Metal, black finish, vented sides and front
      ii. 8” x 8” x 2”
   g. Built-in video scaler: HD video scaler, motion-adaptive deinterlacer, interlacer, intelligent frame rate conversion, Deep Color support, 3D to 2D conversion, content-adaptive noise reduction
3. Manufacturers
   a. Crestron DM-RMC-SCALER-C
   b. Or equal.

2.7 VIDEO TERMINAL EQUIPMENT

A. 19.5” Flat Panel Display (Dais)

   a. Drawing Reference: LCD19
   b. Panel Size: Wide Screen 23.0"(58.4cm) 16:9
      True Resolution : 1920x1080
      Full HD 1080P : Yes
      Pixel Pitch : 0.2652mm
      Brightness(Max) : 250 cd/㎡
      ASUS Smart Contrast Ratio (ASCR) : 50000000:1
      Viewing Angle (CR≧10) : 170°(H)/160°(V)
      Response Time : 2ms (Gray to Gray)
      Display Colors : 16.7M
   c. Stereo Speakers : 2W x 2 Stereo RMS
   d. HDMI In
   e. Manufacturer:
      i. ASUS VH238H.
      ii. Or equal.

B. LCD, 55” Diagonal

1. Drawing Reference: FPNL55
2. Features/Functions:
   a. Panel Type: LCD, LED Backlighting
   b. Professional/commercial grade display warrantied by the manufacturer for continuous operation for not less than two years.
   c. Minimum Viewable Panel Size: 55” diagonal, 16:9 aspect ratio
   d. Maximum Pixel Pitch: 0.923 x 0.923 mm
   e. Native Resolution: 1920 x 1080
   f. Viewing Angle (H/V): 176°/176°
   g. Brightness: 450 cd/m^2
   h. Maximum Response Time: 6 ms
   i. Contrast Ratio: 5000:1
   j. Inputs
      i. VGA (D-sub 15 pin)
      ii. HDMI
      iii. Stereo Mini Jack
   k. Control:
      i. RS-232C
      ii. RJ45
      iii. IR, included IR Remote
   l. Power Consumption: In accordance with California Code of Regulations, Title 20: Division 2, Chapter 4, Article 4, Sections 1601-1608: Appliance Efficiency Regulations
   m. Weight: 70 lbs. Maximum
   n. Operating Temperature: 5-40 degrees C
   o. Operating Humidity: 20-80%
   p. Dimensions: Less than 2” deep.
3. Manufacturer
   a. Samsung ME55B
   b. Sharp
   c. NEC
   d. Or equal

C. LCD, 65” Diagonal

1. Drawing Reference: FPNL65, FPNL70
2. Features/Functions:
   a. Panel Type: LCD, LED Backlighting
   b. Professional/commercial grade display warrantied by the manufacturer for continuous operation for not less than two years.
   c. Minimum Viewable Panel Size: 65” diagonal, 16:9 aspect ratio
   d. Maximum Pixel Pitch: 0.923 x 0.923 mm

e. Native Resolution: 1920 x 1080
f. Viewing Angle (H/V): 176°/176°
g. Brightness: 450 cd/m^2
h. Maximum Response Time: 6 ms
i. Contrast Ratio: 5000:1
j. Inputs
   i. VGA (D-sub 15 pin)
   ii. HDMI
   iii. Stereo Mini Jack
k. Control:
   i. RS-232C
   ii. RJ45
   iii. IR, included IR Remote
l. Power Consumption: In accordance with California Code of Regulations, Title 20: Division 2, Chapter 4, Article 4, Sections 1601-1608: Appliance Efficiency Regulations
m. Weight: 70 lbs. Maximum
n. Operating Temperature: 5-40 degrees C
o. Operating Humidity: 20-80%
p. Dimensions: Less than 2” deep.

3. Manufacturer
   a. Samsung ME65B
   b. Sharp
   c. NEC
   d. Or equal

D. LCD, 90” Diagonal

1. Drawing Reference(s): FPNL90
2. Features/Functions:
   a. Panel Type: LCD, LED Backlighting
   b. Professional/commercial grade display warrantied by the manufacturer for continuous operation for not less than two years.
   c. Size: 90” diagonal
   d. Native Resolution: 1920 x 1080
   e. Pixel Pitch: 0.94mm
   f. Brightness: 700 cd/m^2
   g. Contrast Ratio: 4000:1
   h. Inputs
      i. VGA: Mini D-sub 15-pin
      ii. HDMI
      iii. 3.5 mm diameter-mini stereo jack
   i. Control:

i. RS232C
ii. Included IR Remote

j. Power Consumption: In accordance with California Code of Regulations, Title 20: Division 2, Chapter 4, Article 4, Sections 1601-1608: Appliance Efficiency Regulations
k. Weight: 174 lbs. Maximum
l. Operating Temperature: 5-40 degrees C
m. Operating Humidity: 20-80%

3. Manufacturer
   a. Sharp PN-R903
   b. Samsung
   c. NEC
   d. Or equal

E. Motorized articulating display mount arm.
   1. Drawing Reference: FPMM
   2. Manufacturer:
      a. Alton Systems AM-175-A with motor operator
      b. Wallmountworld PSE-90, FA-MOTORIZED-65INCH-90DEG
      c. Or equal.

F. Dias Display Stand
   1. Drawing Reference: DDS
   2. Features:
      a. VESA Compliant
      b. Adjustable to 22.5-degrees from horizontal.
      c. 26 pound minimum weight capacity.
   3. Manufacturer
      a. Ergonomic Business Solutions EBS102
      b. Or equal.

G. Flat-Panel Display Wall Mount
   1. Drawing Reference: None - provide at locations where wall mount of LCD* and FPNL* devices are indicated except as otherwise provided herein.
   2. Functions:
      a. Can support the required LCD and Plasma Panels supplied by the work of this Project.
      b. Holds rear of panel away from wall ~2" to permit A/V interface mounting behind display.
      c. Permits display to be tilted in the vertical plane for optimum viewing as directed by the Owner’s Representative.
      d. Allows the complete mount and display assembly to not protrude more than 4” out

from wall surface.

e. Designed to mount to 16", 20", 24" center stud systems
f. Panel can be securely fastened to mount using to prevent theft by adding a Owner furnished padlock.
g. Where mounting fasteners are exposed during normal operations, secure mount with tamper-resistant fasteners.
h. Designed to accommodate panels from at least Pioneer, Panasonic, Sharp, Samsung, & LG Electronics
i. Heavy duty construction with steel components
j. UL or ETL listed
k. California OSHPD OPA (seismic restraint pre-approval). Installation to be accordance with OPA.

3. Manufacturers:
   a. Chief Manufacturing, Inc. LTM Series, selected for display and mounting conditions.
   b. or equal.

2.8 SOUND CABLES AND RELATED

A. General

1. Provide cable with electrical conductors of soft drawn annealed copper, bare or tinned, solid or concentric stranded as applies, conductivity not less than 98 percent of pure copper.
2. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. Refer to California Electrical Code, Table 725-61. Cable Uses and Permitted Substitutions.
3. Manufacturer part number specified is for a Listed Type CM construction to indicate intended cable construction and quality.
   a. Code requirements take precedence.
   b. Provide type required by Code at no additional cost to the Owner.

B. FlipTop, Basic

1. Drawing Symbol: FTC
2. Manufacturer:
   a. Crestron FT-600
   b. Or equal.

C. Cable, Microphone and Line Level, General Purpose

1. Drawing Symbol(s): SP, 2A.
2. Description: Shielded, single twisted pair, with #20 AWG color coded stranded conductors and foil shield with drain wire.
3. Performance/Construction

a. Conductors AWG #20.
b. Conductors Stranding: 7 by 28.
c. D.C. Resistance Per 1000 feet 15 ohms maximum.
d. Shield: Aluminum polyester foil with #20 AWG stranded tinned copper drain wire.
e. Diameter 0.24 inch maximum.

4. Where 2A indicated, provide 2 each SP
5. Manufacturer
   a. Belden 8762
   b. West Penn.
   c. Or equal.

D. Cable, Microphone and Line Level, Miniature

1. Drawing Symbol: SP, 2A
2. Restriction: For use within fixed equipment racks only.
3. Description: Shielded, single twisted pair, with #22 AWG color coded stranded conductors and foil shield with drain wire.
4. Performance/Construction:
   a. Conductors AWG #22.
   b. Conductors Stranding: 7 by 30.
   c. D.C. Resistance Per 1000 feet: 20 ohms maximum.
   d. Shield: Aluminum polyester foil with #24 stranded tinned copper drain wire.
   e. Diameter 0.15 inch maximum.
5. Where 2A indicated, provide 2 each SP
6. Manufacturer
   a. Belden 8451, 9451, 1266A.
   b. Alpha.
   c. West Penn.
   d. Or equal.

E. Cable, Antenna, Assistive Listening System

1. Description
   a. Nominal 50 ohms (actual 51 or 52 ohms) coaxial cable.
2. Minimum 97 percent shield coverage.
3. Joint Army Navy (JAN) or Military (MIL) Construction
   a. RG-8/U to JAN-C-17A
   b. RG-8 A/U to MIL-C-17D
   c. RG-9/U to JAN-C-17A.
4. Manufacturer
   a. Belden 8237, 9251 or 8242.
   b. CommScope.
   c. Or equal.

F. Cable, Loudspeaker and D.C. Power

1. Drawing Symbol(s)
   a. #18TP
   b. #16TP
   c. #14TP
   d. #12TP
2. Description
   a. Twisted pair, jacketed, unshielded cables, #12, #14, #16, or #18, as shown on Drawings.
3. Plenum rated where installed in open plenum return voids.
4. Performance/Construction
   a. Conductor, AWG: #12, #14, #16, and #18, as noted.
   b. Maximum diameter
      i. 0.384 inch (#12)
      ii. 0.332 inch (#14)
      iii. 0.256 inch (#16)
      iv. 0.224 inch (#18).
5. Manufacturer
   a. Belden.
      i. #12TP, Belden 8477
      ii. #14TP, Belden 8473
      iii. #16TP, Belden 8471
      iv. #18TP, Belden 9740
      v. West Penn.
      vi. Or equal.

F. Audio & Control Cabling, Underground, in ducts

1. As specified for the applications above with waterblocking construction consisting of two ply tape designed to swell on exposure to water.
2. Jacket is sunlight and moisture resistant
3. NEC CM or CL3 listed or better. Transition to listed cabling type within 50 feet of entering building.
4. Manufacturer listed for underground application subject to extended exposure to standing water.
5. Manufacturer:

a. West Penn (aquaseal)
b. Alpha
c. Belden
d. Commscope/Isotec
e. or equal.

2.9 VIDEO CABLES, COPPER COAX AND RELATED

A. General

1. Provide cable with electrical conductors of soft drawn annealed copper, bare or tinned, solid or concentric stranded as applies, conductivity not less than 98 percent of pure copper.
2. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. Refer to California Electrical Code, Table 725-61. Cable Uses and Permitted Substitutions.
   b. Manufacturer part number specified is for a Listed Type CM construction to indicate intended cable construction and quality.
3. Code requirements take precedence.
   a. Provide type required by Code at no additional cost to the Owner.

B. Cable, Precision Video

1. Drawing Symbol(s): P-VID, V.
2. Description: 100 percent sweep tested from 0.01 to 100 MHz, double braided shield solid center conductor 75 ohms coaxial precision video cable.
3. Performance
   a. Cable Type: Coaxial precision video.
   b. Center Conductor AWG: Twenty (20) bare copper.
   c. Insulation: Polyethylene.
   d. Shield: Tinned copper double braid, minimum 98 percent coverage.
   e. Nominal Impedance: 75 ohms.
   f. Velocity of Propagation: 66 percent.
   g. Attenuation Per 100 feet:
      i. 1.0 MHz: 0.25 dB
      ii. 4.5 MHz: 0.45 dB
      iii. 10.0 MHz: 0.78 dB.
   h. Jacket: Polyethylene.
   i. Diameter: 0.305 inch maximum.
4. Manufacturer
   a. Belden 8281A or 8281B.
   b. Canare
   c. Gepco

d. Or equal.

C. Cable, Miniature Precision Video

1. Drawing Symbol: Miniature Precision Video.
2. Description: 100 percent sweep tested from 0.01 to 100 MHz, braided shield plus foil shield, stranded center conductor 75 ohms coaxial miniature precision video cable.
3. Performance
   a. Cable Type: Coaxial precision video.
   b. Center Conductor AWG: 22 or 23 bare copper.
   c. Center Conductor Stranding: 7 by 30 or 7 by 32.
   d. D.C. Resistance Per 1000 feet: 15 ohms maximum.
   e. Insulation: Cellular Polyethylene.
   f. Shield: 100 percent foil plus trimmed copper braid, 95 percent coverage.
   g. Nominal Impedance: 75 ohms.
   h. Velocity of Propagation: 66 percent.
   i. Attenuation Per 100 feet:
      i. 1.0 MHz: 0.15 dB
      ii. 10.0 MHz: 1.3 dB
      iii. 100 MHz: 5.0 dB.
   j. Jacket: Polyethylene.
   k. Diameter: 0.240 inch maximum.
4. Manufacturer
   a. Belden 9209A.
   b. Canare LV-61S.
   c. Or equal.

D. Cable Set, Audio Video, Manufactured

1. Provide signal type as indicated on Drawings.
2. Manufacturer
   a. Liberty Wire & Cable Interflex Z-200 and Z-300 Series
   b. Markertek
   c. Or equal.

E. Cable, Data Monitor Precision Video

1. Plan Reference(s):
   a. D5
   b. 5DVideo
2. Construction
   a. 5 miniature high resolution coax cables in an overall shielded overall jacket to transmit analog component video based on the Red-Green-Blue-Horizontal Sync-Vertical Sync (RGBHV) transmission method.
   b. Sub cables are color coded Red, Green, Blue, Black, Grey; or approved alternate

color coding scheme.

c. Jacket: Code approved equal for application.
d. Overall five sub cable assembly diameter: 0.56" maximum in raceway applications.
e. Center Conductor AWG: Twenty two (22) ga Silver Plated Copper.
f. Insulation: Foamed Teflon.
g. Shield:
   i. Each subcable is double shielded
   ii. Overall cable has 100% tape shield.

3. Approval/Rating:
   a. UL: Recognized Type CL2P (Article 725 of NEC) for plenum application, riser rated elsewhere.
4. Performance - each sub-cable:
   a. Resistance: 0.0162 ohms/ft nominal @ 20C
   b. Impedance: 75 ohm nominal
   c. Capacitance: 17.5 pf/ft nominal
   d. Velocity of Propagation: 80% nominal
   e. Time Delay: 1.19ns/ft nominal
   f. Maximum Attenuation Per 100':
      i. 10 MHz: 0.8 dB/100 ft.
      ii. 50 MHz: 2.5 dB/100 ft.
      iii. 100 MHz: 3.5 dB/100 ft.
      iv. 200 MHz: 4.6 dB/100 ft.
      v. 300 MHz: 5.0 dB/100 ft.
      vi. 400 MHz: 7.2 dB/100 ft.
      vii. 1000 MHz: 14.6 dB/100 ft.
5. Manufacturers:
   a. Altinex CB5100PL in plenum spaces, riser rated elsewhere.
   b. Extron
   c. Belden
   d. Gepco.
   e. or equal.

F. DVI Cabling

1. Drawing Reference: DVI
2. Features/Functions
   a. Supports single link DVI-D signals up to 1920 x 1200 @ 60 Hz and 1080p/60:
   b. Data rates to 4.95 Gbps
   c. Color depth to 24 bits - 8 bits per color
   d. For cable lengths up to 12 feet: 24 AWG copper wire construction
   e. For cable lengths 25 feet and longer: 22 AWG copper wire construction
   f. NEC CM rated
3. Manufacturers, copper cabling and extenders:

a. Extron
b. or equal.

G. HDMI Extender

1. Drawing Reference: HDMI Extend, HDMI XTD
2. Minimum Features/Functions/Construction/Performance
   a. Select to suit application and distance.
   b. Video
      i. Maximum data rate 6.75 Gbps (2.25 Gbps per color)
      ii. Maximum pixel clock 165 MHz
      iii. Resolution range Up to 1920x1200 or 1080p @ 60 Hz; 8, 10, or 12 bit color depth
      iv. Formats RGB and YCbCr digital video
      v. Standards DVI 1.0, HDMI, HDCP 1.1, CEA-861E
   c. Video input — transmitter
      i. Number/signal type 1 single link HDMI (or DVI-D*)
      ii. Connectors 1 female HDMI type A
   d. Interconnection between transmitter and receiver
      i. Connectors 1 female RJ-45 per unit
      ii. Termination standard ANSI/TIA T568B
      iii. Signal transmission distance Up to 330' (100 m) using manufacturer's recommended cabling assembly.
   e. Video output — receiver
      i. Number/signal type 1 single link HDMI (or DVI-D*)
      ii. Connectors 1 female HDMI type A
3. Manufacturer, provide with with manufacturer's mounting kits and recommended cabling assemblies:
   a. Kramer
   b. Hall Research
   c. Extron
   d. Crestron
   e. Altinex
   f. Liberty Cable
   g. Or equal.

H. VGA Extender

1. Drawing Reference: VGA XTD or as required
2. Provide as required to maintain signal integrity over required cable length
3. Manufacturers:
   a. Any as specified for HDMI extenders above.

2.10 CONTROL AND CONTROL MEDIA CABLING

A. General

1. Provide cable with electrical conductors of soft drawn annealed copper, bare or tinned, solid or concentric stranded as applies, conductivity not less than 98 percent of pure copper.
2. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. Refer to California Electrical Code, Table 725-61. Cable Uses and Permitted Substitutions.
   b. Manufacturer part number specified is for a Listed Type CM construction to indicate intended cable construction and quality.
3. Code requirements take precedence.
   a. Provide type required by Code at no additional cost to the Owner.

B. High Speed, TIA/TIA Category Cabling

1. Drawing Reference:** UTP6-4, where ** denotes cable count
2. Construction:
   a. Provide horizontal copper cable in accordance with:
      i. EIA ANSI/TIA/EIA-568-B.2
      ii. UL 444,
      iii. NEMA WC 66 (Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pair)
      iv. ICEA S-90-661
   b. UTP (unshielded twisted pair),
   c. 100 ohm impedance
   d. Four each individually twisted pair, 22 or 24 AWG conductors,
      i. Color code
         (1) Pair 1 White/Blue Blue
         (2) Pair 2 White/Orange Orange
         (3) Pair 3 White/Green Green
         (4) Pair 4 White/Brown Brown

e. No shield in the sheath.
f. Jacket
   i. Thermoplastic jacket
   ii. Color: Blue unless otherwise indicated.
   iii. Cable imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 2 feet.
   iv. The word "FEET" or the abbreviation "FT" shall appear after each length marking.
   v. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70.
   vi. Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70.

3. Certification
   a. Warrantied by the manufacturer to provide Category 6 performance when installed in accordance with applicable EIA/TIA standards and when terminated with the jacks supplied by the Contractor for this Project.
4. Performance
   a. Assembly electrically meets or exceeds EIA ANSI/TIA/EIA-568-B.2 Category 6 performance standards
5. Manufacturers:
   a. Berk-Tek LANmark-6
   b. Belden/CDT
   c. Berk-Tek
   d. Commscope/Systimax
   e. Commscope/Uniprise
   f. General Cable
   g. Mohawk/CDT
   h. Superior/Essex
   i. or equal
   j.

2.11 CONTROL MEDIA CABLING

A. General

1. Provide cable with electrical conductors of soft drawn annealed copper, bare or tinned, solid or concentric stranded as applies, conductivity not less than 98 percent of pure copper.
2. Comply with applicable Code for insulation, jacket, marking and listing for applicable use.
   a. Refer to National Electrical Code, Table 725-61. Cable Uses and Permitted Substitutions.
   b. Manufacturer part number specified is for a Listed Type CM construction to indicate

intended cable construction and quality.

3. Code requirements take precedence.
   a. Provide type required by CEC at no additional cost to the Owner.

B. Low Speed Audiovisual Cabling

1. Drawing Reference: AVNet
2. 1 cable equivalent to a 1 pair, 18 gauge cable suitable for RS-485 (A/V Net) signaling and remote device powering.
3. Manufacturers:
   a. Crestron
   b. Liberty Wire & Cabling
   c. AMX
   d. Extron
   e. or equal.

C. Shielded High Definition Category Media Cabling

1. Drawing Reference(s):
   a. HCAT MEDIA
2. Features/Functions:
   a. Proprietary 4 twisted-pair cable in overall shield designed to transmit manufacturer's proprietary implementation of HDBaseT
3. Manufacturers:
   a. Crestron DigitalMedia 8G Cable
   b. Liberty Wire & Cabling
   c. AMX
   d. Extron
   e. or equal.

2.12 MISCELLANEOUS PRODUCTS

A. Cable Termination Devices and Related:

1. Screw-type or Tubular Clamp Barrier Blocks:
   a. Buchanan 125, 0625 Series.
   b. Electrovert
   c. TRW-Cinch 140, 141, 142 Series.
   d. Weidmuller .
   e. Pass & Seymour/Legrand.
   f. Phoenix
   g. Or equal.
2. Tubular Clamp Barrier Blocks, High Density, Switch Block Section
   a. Drawing Reference: TB15.
   b. Features/Functions

i. Paired screw terminals on opposite sides of insulating base.
ii. TB15 Base mounts to DIN rail, providing space beneath TB15 to dress field and source cabling.
iii. Terminates range of wire gages used by project – at least 30 gage to 10 gage.
iv. High density:
(1) At least 33 pairs of connections per foot for 12 and smaller gage terminations,
(2) At least 16 pairs of connections per foot for 10 gage terminations.
v. Switch Block Section permits load, such as field devices, to be separated from monitoring panel for testing independent of source then restored without disturbing field wiring terminations.
vi. Rated at least fifteen (15) amperes at 300V AC/DC

c. Approvals
i. UL

d. Manufacturers:
i. Allen Bradley Isolation Switch Blocks,
(1) 1492-H7 for 30 to 12 gage
(2) 1492-CE9 for 10 gage.
ii. Tyco Buchanan 0135 Series.
iii. WECO Electrical Connectors
iv. Altech
v. Curtis Industries
vi. Electrovert
vii. Weidmuller
viii. Pass & Seymour/Legrand
ix. Phoenix
x. or equal.

3. Low Level Audio Cable Termination, Insulation Displacement Products
a. Coordinate with wire size, type and insulation
b. Manufacturer
i. ADC "Dense Patch".
ii. Siemon Model S66M450 with D10 Designation Strip.
iii. Any meeting 110TB under Section 17119 – Communications Termination Blocks and Patch Panels of the Base Building Project
iv. Or equal.

B. Audio and Control Connectors and Related:

1. Circular Audio Connector, Cord, 3 through 5 contacts, gold plated contacts, captive cable clamp strain relief, matte black chrome finish over nickel metal shell
a. Neutrik C-Series, X-Series.
b. Switchcraft.
c. Or equal.
2. Circular Audio Connector, Panel mount, male and female devices to fit same panel cutout including fasteners, 3 through 5 contacts, gold plated contacts, matte black

chrome finish over nickel metal shell, female receptacles locking type:

a. Neutrik D Series Version L.
b. Switchcraft
c. Or equal.

3. Loudspeaker Connector, Panel mount, female devices to fit same panel cutout including fasteners as other panel mount receptacles, 4 contacts, matte black finish Polyamid/graphite shell, female receptacles locking type. UL Component Recognized:

a. Neutrik NL4MP.
b. Switchcraft
c. Or equal.

C. Video Connectors and Related

1. Video Connector, BNC type, 75 ohms, Panel, recessed, flush with panel face, insulated from panel, double female

a. Manufacturer
i. Canare BCJ-JRU.
ii. Tec Nec
iii. Liberty Wire & Cable/Panelcraft
iv. or equal.

2. Video Connector, BNC type, 75 ohms, Panel, recessed, flush with panel face, insulated from panel, single female to solder pin

a. Manufacturer
i. Canare BCJ-RU.
ii. Tec Nec
iii. Liberty Wire & Cable/Panelcraft
iv. or equal.

3. Video connector, BNC type, 75 ohms, cord, crimp applied. Coordinate with cable.

a. Manufacturer
i. Amp.
ii. Amphenol.
iii. Augat/LRC Products
iv. Canare.
v. Kings.
vi. Liberty Wire & Cable/Panelcraft
vii. RFI/Celltronics.
viii. Trompeter.
ix. or equal.

4. Video Precision 75 ohms Terminator, BNC:

a. Manufacturer
i. Canare BCP-TA
ii. Trompeter TNAI-1-75.
iii. or equal.

5. XGA Connectors, DB15
   a. Drawing Reference HD15
   b. Manufacturer
      i. Amp.
      ii. Amphenol.
      iii. Canare.
      iv. Kings.
      v. Liberty Wire & Cable/Panelcraft
      vi. RFI/Celltronics.
      vii. or equal.

D. Custom Facility Panels and Rackmount Auxiliary Panels

1. Drawing Reference(s):
   a. MP* - Media Panels, where * is a number indicating the panel type.
   b. FP* - Facility Panels, where * is a number indicating the panel type.
   c. Aux Panel
2. Provide connector types and plate finish as shown. If none shown, provide:
   a. Rack mount panels:
      i. 16 gauge minimum, cold rolled steel or 1/8" minimum aluminum, finish to match rack finish.
      ii. At contractor's option, fabricate using rack mount panels with Decora/Decorator openings and steel plates with specified connectors. Match insert color to panel color provided. Refer to Rack Panel with Decora Openings below.
   b. Wall Panels: 16 gauge minimum cold rolled steel, finish to match surrounding electrical and other low voltage panels.
3. Manufacturers, Rack Mount Panels
   a. BGW Systems Inc.
   b. Conquest
   c. Middle Atlantic Products Universal Connector Panel
   d. Middle Atlantic Products Universal Connector Panel, Modular Custom Connector Panel Systems
   e. ProCo Sound, Inc.
   f. Ultimate Plates and Panels
   g. or equal.
4. Manufacturers, Wall Panels
   a. PanelCrafters Division of Liberty Wire & Cable, Classic Series
   b. FSR
   c. RCI Systems
   d. Middle Atlantic
   e. Ultimate Plates and Panels
   f. Whirlwind
   g. Or equal.

5. Manufacturers, Decora/Decorator connector inserts:
   a. Connector Plates by Radio Design Labs. Provide specified connectors rear mounted in D-Blank insert for connector combinations not available from RDL.
   b. Grey by Pathway Connectivity Solutions. Provide specified connectors rear mounted in 5100 insert for connector combinations not available from Pathway Connectivity Solutions.
6. Manufacturers, Rack Mount Decora Panel Openings
   a. Lowell Manufacturing LD8-RMP with Lowell DBB-4 blank Decora plates at openings not fitted with equipment.
   b. Middle Atlantic DECP Series
   c. or equal.

2.13 POWER DISTRIBUTION EQUIPMENT:

A. Comply with applicable Codes. Provide UL Listed devices suitable for commercial use. Provide all junction boxes, raceway, fittings, wire, supports and fastenings as required for complete installation. Contractor to coordinate plug end of selected strip with rack power receptacles installed under the work of Division 16. Unless otherwise noted, provide receptacles of NEMA 5-15R configuration.

B. Power Sequencer System
   1. Drawing References
      a. Power Sequencer
      b. Fire Alarm Interface – provide where required to shunt system operation on receipt of closure from Fire Alarm system.
      c. Sold State Relay (SSR) SSR1 through SSR7
   2. Features
      a. Power sequencing system.
      b. Solid state switching, zero crossing.
      c. Sequencing on power up and power down.
      d. Front panel button and external closure activation.
      e. Alarm terminal to sequence the system down when tripped.
      f. UL Listed.
   3. Manufacturer
      a. FSR Inc. Power Products Group SPC-20 Power Sequencer and SPC-20X Solid State Relay
      b. Furman
      c. Or equal.

C. UPS, Rack Mounted, 1400 VA
   1. Drawing Reference: UPS10
   2. Features/Functions/Performance:
      a. Provide continuous, no-break power with sine wave output.
      b. Size to carry connected load at least 10 minutes following loss of power, after at

least two hours of charge time.

c. Provide Transient Over-Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B.
d. Provide complete isolation from Line.
e. Provide output voltage regulation to ANSI C84.1 for computing equipment.
f. SNMP manageable and status reporting to Owner's Management console. Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated.
g. Rack Mounted

3. Manufacturer:
   a. SmartUPS 1400 RM series by American Power Conversion (APC)
   b. Trip-Lite
   c. Or equal.

D. Power Supplies and Related:

1. Drawing Reference: PS24.
2. Relay and Lamp Power Supply:
3. 24 VDC, regulated within 5%. Ripple not greater than 1.5%. Output current rating at least 150% of maximum possible load. Circuit breaker or intrinsic over current protection. UL Recognized or UL Listed.

E. Full Height Receptacle Strip, One (1) Circuit, 15A

1. Features/Construction:
   a. Not less than 60" Long
   b. Not less than eleven (11) 15A receptacles
   c. Integral circuit breaker
   d. NEMA 5-15P plug on 6' cord.
   e. UL Listed Assembly
   f. Provide mounting hardware as necessary to attach to rack interior.
2. Manufacturers.
   a. Wiremold Series 7011ULBC.
   b. Lowell ACS 1524
   c. Geist NSVB200-101S15
   d. Hubbell PR206
   e. Leviton
   f. Middle Atlantic
   g. Chatsworth 12848-701
   h. or equal.

F. Full Height Receptacle Strip, One (1) Circuit, 20A

1. Features/Construction:
   a. Not less than 70" Long

b. Not less than eleven (11) 15A receptacles
c. Integral circuit breaker
d. NEMA 5-20P plug on 6' cord.
e. UL Listed Assembly
f. Provide mounting hardware as necessary to attach to rack interior.

2. Manufacturers. Contractor to coordinate selected strip with rack power receptacles installed under the work of Division 26.
   a. Geist NSVB200-102S20
   b. Hubbell PR20820DRTL
   c. Leviton P104x series
   d. Lowell ACS-2024
   e. Midde Atlantic PD-1020C-NS
   f. Wiremold Series 7011ULBC20.
   g. Chatsworth 12848-705
   h. or equal.

G. Rackmount Power Panel, Horizontal Mount, User Aux device use:

1. Drawing Reference: POWER.
2. Functions/Features:
   a. Front face of panel shall provide two electrical power outlets and a switch. An indicator lamp shall show the presence of AC power when on. The front face of panel shall have a black finish. The rear face shall provide a minimum of at least four receptacles. The panel shall be racked mounted in a maximum of two rack units. The panel shall be Code approved and UL rated for this application.
3. Manufacturers:
   a. Hubbell MCCPSS19TS
   b. Leviton 4515
   c. Geist SP124-1020
   d. Or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.

B. Furnish and install (herein, "provide") all materials, devices, components, and equipment required for complete, operational systems.

3.2 PRECONSTRUCTION PROGRAMMING MEETING

A. Not less than 30 days prior to the scheduled completion of the project, Contractor to initiate a request of the Owner's Representative to schedule an Audiovisual Systems programming meeting.

1. The Owner's Representative will schedule the meeting at the reasonable mutual convenience of the Contractor and the Owner's technical systems representatives.
2. The purpose of the meeting is for the Owner's Representative to indicate to the contractor how the programmable interfaces of the audiovisual systems are to be implemented, including:
   a. Button assignments and labels for physical button panels
   b. Touchscreen menu hierarchy, scene arrangement, button and background colors, text size, logos
   c. Whether authorization codes or passwords will be required to access special functions/menus.
3. Contractor to document the information received from the Owner's Representatives at this meeting.
4. Contractor to submit the documentation of the requirements meeting, along with their proposed response to the Owner's programming requirements in the form of screen shots and system menu flow diagrams as required under Section 27 41 00 – Common Work Results for Audiovisual Systems, 1.4 D Submittals.

3.3 WIRING CLASSIFICATION AND RELATED

A. Audio Signal Wiring Classification:

1. Type A-l: Microphone level wiring less than -30 dBµ, 20 Hz to 20 kHz.
2. Type A-2: Line level wiring -30 dBµ to +24 dBµ, 20 Hz to 20 kHz.
3. Type A-3: Loudspeaker level or circuit wiring greater than +24 dBµ, from 20 Hz to 20 kHz.

B. Video and Related Signal Wiring Classification:

1. Type V-1: Baseband and composite video wiring 1 volt peak-to-peak into 75 ohms, 0 to 10.0 MHz.
2. Type V-2: Synchronization and switching pulse wiring 4 volts peak-to-peak into 75 ohms, 15.62 to 15.75 kHz.
3. Type V-3: Color subcarrier wiring 0 to 4 volts peak-to-peak into 75 ohms, 3.57 to 4.43 MHz.
4. Type V-4: MATV system wiring 0.1 to 1000 uV peak-to-peak into 50 or 75 ohms, 47 to 890 MHz.

C. Control Signal Wiring Classifications:

1. Type C-1: DC control wiring 0 to 50 volts.
2. Type C-2: Synchronous control or data wiring 0 to 40 volts, peak-to-peak.
3. Type C-3: AC control wiring 0 to 48 volts, 60 Hz.

D. Additional Wiring Classifications:

1. Type M-1: DC power wiring 0 to 48 volts.
2. Type M-2: AC power wiring greater than 50 volts, 60 Hz.

E. Wiring Combinations:

1. Except as indicated herein, conduit, wireways and cable bundles shall contain only wiring of a single classification. The following combinations are acceptable in conduit, or cable harnesses. Additional acceptable combinations may be indicated on the Contract Drawings.
   a. Types A-1, C-1, and M-1.
   b. Types A-2, C-l, C-2, and M-l, runs less than twenty (20) feet.
   c. Types A-2, C-1, and M-1.
   d. Types A-3, C-1, C-2, and M-1.
   e. Types A-2, V-1, and V-3.
   f. Types V-1, V-2, V-3, and C-1.
   g. Types M-2 and C-3.

3.4 WIRE AND CABLE INSTALLATION

A. Provide permanent identification of run destination at all raceway terminations.

B. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.

C. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels or equipment enclosures.

D. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards. Outside buildings, make splices only in designated manholes and/or handholes. Protect splices outside of buildings with splicing kits equivalent to Scotchcast Re-enterable. Make splices only with connectors or terminal devices specified herein. Document all splices on Record Drawings.

E. Verify that all raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.

F. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.

G. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.

H. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Provide tool formed thermal expansion loops at cable at manholes, handholes and at both sides of all fixed mounted equipment. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.

I. Secure all wire and cable run vertically for continuous distances greater than thirty (30) feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar devices appropriate to weight of cable. For all other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.

3.5 SIGNAL POLARITY CONVENTION

A. Maintain consistent absolute signal polarity at all connectors, patch points and connection points accessible in the system. Comply with AES26-2001.Where applicable, a positive polarity electrical signal shall yield positive acoustic pressure from the loudspeakers.

B. Audio signal connector convention: Comply with AES 14-1992 (r1998)

Signal	Connector	Wire
Signal Phase	Pin 2	Red or White
Signal Anti-Phase	Pin 3	Black
Signal Ground	Pin 1	Drain Wire

C. Video and RF/MATV Connector Convention:

Signal	Connector	Wire
Signal Phase	Center Pin	Center conductor
Signal Anti-Phase	Shell	Shield
Signal Ground	Shell	Shield

3.6 WIRING PRACTICE

A. Land all non-coaxial field wiring entering each equipment rack at specified terminal devices prior to connection to any equipment or devices within racks. At Contractor's option, such terminals may be located in the equipment racks or in the terminal cabinets provided. Coordinate such selection with Project construction sequence and test procedures specified herein.

B. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Indicate the number designated on the associated field or shop drawing or run sheet, as applies. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Conform with the requirements of Section 27 41 00.

C. Apply all crimp connectors only with manufacturer's recommended ratchet type tooling and correct crimp dies for connector and wire size. Plier type crimp tooling shall not be acceptable.

D. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.

E. Make all connections to screw-type barrier blocks with insulated crimp-type spade lugs. Lugs are not required at captive compression terminal type blocks. Provide permanent designation strips designed for use with the terminal blocks provided. Make neat, intelligible markings with indelible markers equivalent to "Sharpie".

F. Tin terminated shield drain wires and insulate with heat shrinkable tubing.

G. Use only rosin core 60/40 tin/lead solder for all solder connections.

H. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.

I. Termination and buildout resistors and related circuit correction components shall be visible. Do not install in connector shells or internally modify equipment. Show locations on Record Drawings.

J. Correct any and all of the following unacceptable wiring conditions:

1. Deformed, brittle or cracked insulation.
2. Insulation shrunken or stripped further than 1/8" away from the actual point of connection within a connector, or on a punch block.
3. Cold solder joints.
4. Flux joints.
5. Solder splatter.

6. Ungrommeted, unbushed, or uninsulated wire or cable entries.
7. Deformation or improper radius of wire or cable.

3.7 FINISHES

A. Finishes and materials for contractor fabricated assemblies such as racks, custom control panels, brackets, blank panels, equipment mounting in furniture or casework, speaker baffles, speaker grille material and in general any item or component herein which is visible shall adhere to the following:

1. Finish shall be as directed by the Owner's Representative.
2. In the event that the Owner's Representative provides no direction as to finish, finish shall match exactly the surrounding and adjacent surfaces.
3. Wooden speaker back boxes and baffles shall be painted flat black if not otherwise finished or stained.

3.8 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT FABRICATION

A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.

B. Within each equipment enclosure, provide a full-height multi-circuit ground outlet strip with branch circuit count as shown on drawings; locate on the left side of the equipment enclosure, as viewed from the rear. In each enclosure provide number of receptacles required by present and future equipment indicated on drawings, plus at least two spare receptacles. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.

C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.

D. Maintain separation of wiring classifications as specified herein. Separately dress, route and land microphone and line level cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level and control cables on the left side of the equipment enclosure, as viewed from the rear.

E. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.

F. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.

G. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.

H. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible without cutting apart the harness.

I. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.

J. At each equipment backboard, provide UL Listed surge suppressing multi-outlet assembly with at least six (6) receptacles.

3.9 EQUIPMENT RACK AND EQUIPMENT TESTING AND ADJUSTING PROCEDURES

A. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Request and coordinate verification of submitted test data by the Owner's Representative. Correct all non-conforming conditions prior to shipment to Project Site. Perform at least the following procedures:

B. Preliminary: Verify:

1. Grounding of devices and equipment. Integrity of signal and electrical system ground connections.
2. Proper provision of power to devices and equipment.
3. Integrity of all insulation, shield terminations and connections.
4. Integrity of soldered connections. Absence of solder splatter, solder bridges.
5. Absence of debris of any kind, tools, etc.
6. Routing and dressing of wire and cable.
7. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.
8. Mechanical integrity of all support provisions.

C. Rig temporary power and grounding. Comply with all applicable Codes, regulations and ordinances.

D. Determine the proper sequence of energizing systems to minimize the risk of damage. Energize. Burn in for at least 168 hours.

E. Sound Systems:

1. Gain control settings: Establish tentative normal settings for all gain controls. Set all

equalizers flat. Set all automatic gain control devices to bypass. Terminate power amplifier outputs with power load resistors with resistance value within 10% the nominal output impedance of the respective amplifier. Adjust all gain controls on equipment for optimum signal-to-noise ratio and signal balance and, unless they are sub-panel mounted, cap them to prevent tampering. Unless specified or directed otherwise, adjust gains such that in a given system the "front end" operates at unity gain and maintains 10 dB of clip margin referenced to the first onset of clipping of the associated power amplifier(s). Measure and document system gains at 1 kHz. Settings may require further adjustment by the Contractor, a result of testing by the Owner's Representative.

2. Freedom from parasitic oscillation and radio frequency pickup: Maintain previous setup. Set up for each mode of operation specified in the functional requirements; verify that all systems are free from spurious oscillation and radio-frequency pickup using broadband oscilloscope. Correct any such defects.
3. Hum and noise level/signal to noise level/signal to crosstalk level: Maintain previous setup. Terminate microphone and line-level inputs with shielded resistors of 150 and 600 ohms, respectively. Set available variable gain controls such that full power amplifier output would be achieved with -40 dBm input level at a microphone input and +12 dBm at a line-level input. Measure and document the specified parameters of the system overall for each microphone input channel and line-level input channel. Compare with nominal signal level.
4. Total Harmonic Distortion: Maintain previous setup. Measure at reference operating level at least at 63 Hz, 125 Hz, 1 kHz, 10 kHz.

F. Baseband Video Systems:

1. Picture Monitors:
   a. Apply crosshatch. Verify linearity.
   b. Apply red field. Adjust purity.
   c. Apply SMPTE bars and PLUGE. Adjust to standards.
2. Video Path Test: Use manufacturer's procedures. Use full field or line signals.

G. Data/Graphics Systems:

1. Projector:
   a. Apply crosshatch. Converge at design distance. Verify linearity.
   b. Apply red, green and blue field. Adjust purity.
2. Wideband Component Analog Video Path Test: Use manufacturer's procedures.

H. Control System:

1. Demonstrate complete operation.

3.10 PROJECTION SCREEN INSTALLATION

A. Inspection

1. General: Examine surfaces and rough framing to determine suitability to install screen and mount. Do not start work until unsatisfactory conditions are corrected.

B. Installation

1. Install screen and projector mount horizontal and plumb for proper operation per manufacturer's recommendations. Securely anchor to supporting structure to withstand all loading conditions and strain of service.

C. Adjustment

1. Adjust units as required for smooth operation and alignment as required.
2. Just prior to final acceptance of project, clean the screen surface according to the manufacturer's instructions.
3. Protect completed work from damage until acceptance by the Owner's Representative.

3.11 LOUDSPEAKER ASSEMBLY INSTALLATION

A. Loudspeakers:

1. Verify proper installation of loudspeaker enclosures and related support.
2. Verify that no loudspeaker assembly is subjected to stresses or loading effects in any way contributing to possible extraordinary failure.

3.12VIDEO PROJECTOR ASSEMBLY INSTALLATION

A. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of such equipment. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Submit in timely manner.

B. Comply with applicable Code and the requirements of the Authorities having jurisdiction.

C. Provide safety factor greater than six (6) or as required by Code, whichever is greater.

D. Mountings shall:

1. Permit projector lens to align with top of projection screen.
2. Permit Video Projector to be re-oriented at least plus or minus 3o from angles shown on the Contract Drawings for optimum picture.
3. Maintain precise location and orientation of Video Projector after such adjustment when subject to normal building motion and Code defined seismic induced building motion.

E. Do not apply any load to building structure without first obtaining written approval of the Owner’s Representative. Obtain per Project procedures.

F. During Acceptance Testing, adjust orientation of Video Projector as directed to achieve optimum picture. Provide workers and ladders as required. Perform such adjustment with no claim for additional cost or time.

3.13 PERMANENTLY INSTALLED MICROPHONES

A. General

1. Orient generally as shown in the plans with respect to area of intended pickup.

B. Ceiling Mount Microphones

1. Review indicated mounting location in the field prior to installation. Verify that location is not associated with excessive levels of vibration or background noise (due to HVAC, Projector fans and loudspeakers installed under the work of this or other projects, audible occupancy sensors. Report such conditions to the Owner's Representative and obtain direction prior to proceeding.
2. Coordinate installation location of boundary microphones with final floor plan for maximum uniformity of coverage, and maintainance of unobstructed line-of-site between the projector(s) and the screen(s).

3.14 PERMANENTLY INSTALLED PROGRAM AUDIO SPEAKERS

A. At projection screen conditions,

1. Coordinate the installation location with the projector screen to maintain symmetry.
2. Place speakers indicated for mounting at underside of ceiling oriented to place their long dimension parallel to the ceiling plane.

B. Provide resilient mounting vibration isolation at all wall and roof deck supported loudspeakers to minimize coupling of program audio sound into other building spaces. This requirement does not apply to ceiling supported distributed ceiling speakers.

C. Dress cabling neatly and out of side of audience.

D. Orient on adjustable speaker mounts for maximum uniformity of coverage for audience area and maximum gain before feedback at presenter microphones.

3.15 SYSTEMS PERFORMANCE TESTING AND ADJUSTING PROCEDURES

A. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Review and Testing. Perform at least the following procedures:

1. Mechanical: Verify:
   a. Integrity of all support provisions.
   b. Absence of debris of any kind, tools, etc.
2. Power and Isolated Ground: Verify:
   a. Isolation of Isolated Ground system from raceway and related ground.
   b. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
   c. Proper provision of power to devices and equipment.

3. Signal Wiring: Verify:
   a. Integrity of all insulation, shield terminations and connections.
   b. Integrity of soldered connections. Absence of solder splatter, solder bridges.
   c. Routing and dressing of wire and cable.
   d. Continuity, including conformance with wire designations on running sheets, field and shop drawings.
   e. Absence of ground faults.
   f. Polarity.
4. Use the proper sequence of energizing systems to minimize the risk of damage. Energize.
5. Sound Systems, Electronic Tests; confirm:
   a. Gain at 1 kHz.
   b. Maximum output.
   c. Input clipping level.
   d. Frequency response.
   e. Total harmonic distortion.
   f. Signal to noise ration.
   g. Signal to crosstalk ratio.
6. Electro/Acoustic Tests:
   a. Uniformity of coverage.
   b. Electronic and acoustic frequency response/one-third octave equalization. Measure at ear level. Comply with applicable portions of ANSI (SMPTE) PH22.202M-1984, "B chain electro-acoustic response - control rooms and indoor theaters." Adjust to "curve X of B chain characteristic". Owner's Representative will direct final adjustment.
   c. Maximum continuous sound pressure level (in the reverberant field). Drive systems with broadband pink noise. Sustain for at least five (5) minutes with no system damage. Measure for "A" and "C" weightings at ear level on loudspeaker axis. Turn off noise.
   d. Acoustic signal-to-noise ratio referenced to the specified maximum continuous sound pressure level in the reverberant field. Measure for "A" and "C" weightings at ear level on loudspeaker axis with mechanical systems operating. Present comparison with previous measurement.
7. Video Systems:
   a. Picture Monitors:
      i. Apply crosshatch. Verify linearity.
      ii. Apply red field. Adjust purity.
      iii. Apply SMPTE bars and PLUGE. Adjust to standards.
   b. Video Path Test: Use NTC Report No. 7 procedures. Use full field or line signals.
      i. Insertion Gain.
      ii. Gain/Frequency Distortion.
8. Control System: Demonstrate complete operation.

3.16 LABELING

A. Conform with the requirements of Section 27 41 07 – Identification for Audiovisual Systems.

B. Provide permanent "wedge" type labels on all controls, as applies, to indicate correct settings after systems performance testing and adjustment procedures have been successfully completed.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes Broadband System (Cable Television) distribution including but not limited to:
   1. Headend active amplification, equalization and pads
   2. Provision to block on-site generated channels from leaving the building through the Community Antenna Television (CATV) service feed.
   3. Broadband distribution including
      a. Broadband passives
      b. Broadband cable and patch cords
      c. Related testing.
   4. Areas to receive broadband television signal are as indicated and scheduled on the plans.

B. Related Work in Other Sections
   1. Division 26
      a. Power for the work of this Section.
   2. Section 27 05 00 – Common Work Results for Communications: Applies to Work of this Section.
   3. Section 27 05 26 – Grounding and Bonding for Communications Systems
      a. Provides grounding of Broadband passives provided under Work of this Section.
   4. Section 27 05 29 – Hangers and Supports for Communications Systems
   5. Section 27 05 33 – Conduits and Backboxes for Communications Systems
   6. Section 27 05 53 – Identification for Communications Systems defines labeling requirements for the work of this Section.
   7. Section 27 11 16 – Communications Cabinets, Racks, Frames and Enclosures
   8. Section 27 11 19 – Communications Termination Blocks and Patch Panels
   9. Section 27 11 23 – Communications Cable Management
   10. Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips
   11. Section 27 13 00 – Communications Interior Backbone Cabling
   12. Section 27 41 16 - Receives signal generated by the work of this Section at Program Rooms and A/V Equipment Racks.

A. Related Work by Others
   1. Owner
      a. Orders CATV service from franchised service provider. Obtains franchised CATV service provider's set-top boxes in types and quantities as necessary to decode encypted digital program streams required for the Owner's building operations.

1.2 References

A. Usage: In accordance with Section 01 42 00 – References.
   1. Code of Federal Regulations (CFR)

a. Part 68, Federal Communications Commission. Part 76, Cable Television Rules and Regulations

1.3 Definitions

A. Composite Triple Beat Ratio: The ratio of visual carrier level to composite third order distortion products.
B. Cross Modulation Ratio: The ratio of visual carrier level to coherent spurious signal level (i.e. intermodulation products).
C. Carrier to Noise Ratio: The ratio of visual carrier to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.
D. DBS: Direct Broadcast Satellite
E. Signal Levels
1. Information Note: 0.775 Volt equals 0 dBu equals 0 dbm for a circuit terminated in 600 ohms direct current resistance.
2. Microphone Circuits: Minus 30 dBu or less.
3. Audio Line Level Circuits: Minus 30 dBu to plus 24 dBu; equivalent to minus 30 dBm to plus 24 dBm for a 600 ohms terminated circuit.
4. Loudspeaker Level Circuits: More than plus 24 dBu.
5. Video Line Level Circuits: 1.0 Volt, peak to peak composite signal.
6. Radio Frequency (RF), Television Circuits: Plus 6 to plus 72 dBmV (0 dBmV equals 1,000 microvolts).
F. Characteristic Impedances
1. Microphone Circuits: 50 to 250 ohms source, 150 to 1500 ohms terminating, electrostatically and electromagnetically balanced to ground.
2. Audio Line Level Circuits: 600 ohms maximum source, 600 ohms minimum terminating, line to line, electrostatically and electromagnetically balanced to ground.
3. Video Line Level Circuits: 75 ohms maximum source, 75 ohms minimum terminating to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.
4. Radio Frequency (RF) Television Circuits: 75 ohms nominal to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.

1.4 System Description

A. Summary Description
1. System receives feed from CATV service provider in broadband RF format.
2. System redistributes CATV signal amplified and equalized to indicated drop locations.
3. Provides for future reverse channel (T-Channel) operation of system and provides means to block reverse channels from feeding neighborhood through CATV service entrance.
B. Performance Requirements, Broadband Cabling
1. The specified cable performance, pro-rated for the total link distance.
C. Performance Requirements, Broadband System
1. Radiation shall comply with Title 47, Code of Federal Regulations, Part 76, Cable Television Rules and Regulations.

2. Provide interference-free distribution of any of the scheduled reception channels and allow for future distribution of internally generated forward and reverse channels.
3. The Television Allocation Study Organization (TASO) Grade of the signal of any channel when viewed on a standard commercial television receiver at any Broadband System receptacle tapoff outlet shall not be less than the TASO Grade of the same channel viewed on the same receiver when connected directly to the Broadband Optical Fiber Receiver through a passive attenuator.
4. Provide for Cable Television (CATV) compatible adjacent channel operation with bandwidth to at least 1 GHz.
5. Bandwidth of broadband distribution amplifiers shall be from 54 MHz to 1 GHz in the forward direction, unless otherwise indicated on the Communications Series Drawings.
6. Passive elements shall permit upstream (reverse channel) transmission of 5 MHz to 42 MHz sub-low band Very High Frequency (VHF) television channels from any Faceplate to the building entrance facility.
7. Provide amplification at communications rooms, such that upon adjustment of the distribution facility, each MATV outlet will realize output levels of:
8. Plus 6 to plus 12 dBmV from 54 to 450 MHz nominal, not greater than plus 15 dBmV at any Faceplate.
9. Not less than plus 3 dBmV above 450 Mhz.
10. The signal level from any channel to any adjacent channel shall not vary more than 2 dB at the Faceplate.
11. Long Term Variations in Amplitude: Not to exceed 3 dB.
12. Amplitude Response within any TV Channel: Not to exceed plus 1.0 dB.
13. Amplitude Response for Entire Spectrum Sector: Not to exceed plus and minus 3 dB.
14. Visual Carrier to Noise Ratio: Not less than 50 dB.
15. Composite Triple Beat Ratio: Not less than 55 dB.
16. Cross Modulation Ratio: Not less than 57 dB.
17. Visual Carrier to Hum Modulation Ratio: Not less than 63 dB.
18. Visual Carrier to Reflections Ratio: Not less than 46 dB.
19. In the event that a specific device not meeting the above performance parameters is shown in the Contract Documents as included in the signal chain, the manufacturer's performance specifications of that device shall prevail, with the exception of Radiation, which will not be waived.

D. Channel Allocation Summary, Broadband System
1. Per the Owner's basic service lineup at the time of system commissioning.
2. Assume the following CATV frequency channels will be used and provided for through the headend electronics and distribution systems provided by the work of this contract.
3. CATV Channels 2-79 forward direction.

1.5 Submittals

A. Conform with Section 27 05 00 - Common Work Results for Communications

1.6 Quality Assurance

A. Mock-Ups
1. At one Communications Room backboard, lay out and install distribution equipment in conformance with submitted large scale layout drawings.
2. Obtain review of the Owner's Representative before proceeding with installation of distribution equipment at other Communications Rooms in the project.

B. Test Equipment
1. Provide in conformance with the applicable requirements of Section 27 05 00 Common Work Results for Communications.
a. Broadband Signal Level Meter, 5-750 MHz. Acterna CLI-1750, Sadelco, Blonder Tongue, or equal.
b. Broadband Signal Generator, 5-750 MHz - Acterna LST-1700, Avcom, Agilent or equal.
c. Spectrum Analyzer, 5-750 MHz. Tektronix 2715, Avcom, or equal.
d. True RMS Audio-Frequency Digital Volt-Ohm-Millimeter.
e. Domestic television receiver with Cable Television frequency plan.
f. Other items of equipment or materials required to demonstrate conformance with the Contract Documents.

PART 2 - PRODUCTS

2.1 Broadband Head End Equipment

A. Diplex Filter
1. Drawing Symbol: BBDF
2. Manufacturer:
a. Blonder-Tongue DSV Series.
b. Microwave Filters.
c. Communications & Engineering Corp
d. Jerrold
e. or equal.

2.2 Broadband Distribution

A. Broadband Indoor Distribution Amplifier, 750 MHz, 30 dB Gain, Uni-Directional
1. Plan Reference: BBIDAU750-30
2. Listing: UL.
3. Performance
a. Forward Path:
b. Bandwidth: 49-750 MHz.
c. Flat Gain: Not less than 32 dB with at least 10 dB of adjustment.
d. Cross modulation, composite triple beat and hum modulation each at least 3 dB better than minimum system specifications herein.
e. Unidirectional
4. Manufacturers:
a. Blonder-Tongue BIDA750-30
b. Pico Macom PIDA-750
c. Scientific-Atlanta.
d. Broadband Engineering.

e. Triple Crown.
f. or equal .

B. Broadband Indoor Distribution Amplifier, 750 MHz, 30 dB Gain, Bi-Directional
1. Plan Reference: BBIDAB750-30
2. Listing: UL
3. Performance:
a. Forward Path: As for BBIDAU750-30
b. Reverse Path: Bandwidth: 5-36 MHz.
c. Flat Gain: Not less than 20 dB with at least 15 dB of adjustment.
d. Cross modulation, composite triple beat and hum modulation each at least 3 dB better than minimum system specifications herein.
e. Bi-Directional.
4. Manufacturers:
a. Blonder-Tongue BIDA 75A-30
b. Pico Macom PIDA-750
c. Scientific-Atlanta.
d. Broadband Engineering.
e. Triple Crown.
f. or equal.

C. Broadband Indoor Distribution Amplifier, 750 MHz, 10 dB Gain
1. Plan Reference: BBIDA750-10
2. Listing: UL
3. Performance:
a. Forward Path:
b. Bandwidth: 49-750 MHz.
c. Flat Gain: Not less than 10 dB.
d. Cross modulation, composite triple beat and hum modulation each at least 3 dB better than minimum system specifications herein.
e. Unidirectional.
4. Manufacturers:
a. Pico Macom CDA10
b. Blonder-Tongue
c. Scientific-Atlanta.
d. Broadband Engineering.
e. Triple Crown.
f. or equal.

D. L-Band Amplifier
1. Drawing Reference: BBIDA 2050-50
2. Features/Functions/Minimum Performance
a. Output Level: +1 dBm (50 dBmV) at 2050 MHz
b. Gain
i. 15 dB Gain Control Range
ii. 12 dB Fixed Slope
iii. 950 MHz: 25-40 dB
iv. 2050 MHz 37-52 dB
c. Flatness Noise Figure: ± 1 dB
d. Noise: 6 dB
3. Listing: UL
4. Manufacturers:
a. Blonder-Tongue LDA-50
b. Pico-Macom

c. Quality RF Services, Inc.
d. or equal.

E. Broadband Modulator, Agile:
1. Drawing Reference: BBMODA-YY, where YY indicates the channel output.
2. Function/Features/Performance:
a. Modulate audio and video signals on to TV channel.
b. Channelized.
c. Passes BTSC stereo signal.
d. Dual SAW filters.
e. Output level: Not less than +40 dBmv, 10 dB adjustable.
f. Audio/Video Ratio Control: -9 dB to -25 dB adjustable.
g. Video Carrier Tolerance: +/- 2.5 kHz.
h. Audio Carrier: Phase locked at 4.5 MHz above video carrier.
i. Output Stability: +/- 1 dB.
j. Spurious Response: -60 dB.
k. Input Video Level: 0.5 V p-p for 87.5% modulation.
l. Input Video Signal Format: Composite NTSC, negative sync, 75 ohms.
m. Tilt of 60 Hz Square Wave: 1%.
n. Differential Gain: Not to exceed +/- 20%.
o. Differential Phase: Not to exceed +/- 10%.
p. Chrominance-luminance delay inequality: Less than 170 nsec.
q. Input Audio Impedance: 600 ohms balanced.
r. Minimum Input for 25 kHz Peak Deviation: 300 mv at 1 kHz or lower.
s. Preemphasis: 75 microsecond standard, defeatable for BTSC operation.
t. Harmonic Distortion: Less than 1%, 50 Hz to 15 kHz at 25 kHz deviation.
u. Frequency Accuracy of Audio Modulation: +/- 1% dB, 50 Hz to 15 kHz.
v. Metering or indication of audio and video modulation.
3. Performance:
a. Output Frequency Range: 50-750 MHz, .25 MHz increments.
b. Output level: at least +40 dBmV
c. Noise Level: -77dB
d. Distortion: -60 dB
4. Construction
a. 1 IF loop.
b. 1 Baseband Video Input
c. 2 (Stereo) unbalanced line level audio inputs
5. Manufacturers:
a. Blonder-Tongue AM Series AM-40-750B (Design Basis), provide Options as required to meet specified functionality.
b. Blonder-Tongue CAM Series
c. Cadco M-160
d. Drake VM1550
e. Motorola S450M-II
f. Olson Technology, Inc.
g. Pico Macom PM45

h. Standard Communications
i. or equal.

2.3 Broadband Passives

A. General
1. Provide 50 to 1000 MHz bandwidth in the forward path, 5 to 45 MHz reverse path.
2. Provide Electromagnetic interference shielding effectiveness greater than minus 120 dB.

B. Directional Couplers and Taps
1. Manufacturers
a. Blonder-Tongue SRT Series.
b. Pico Macom.
c. Regal.
d. or equal.

C. Grounding Block
1. Drawing Symbol: GB, LP.
2. Comply with NEC 820-7.
3. Bandwidth to at least 1000 MHz.
4. Manufacturer
a. Pico Macom GRB Series.
b. Gilbert.
c. Regal.
d. or equal.

D. RF Attenuator
1. Drawing Symbol: PAD
2. Manufacturer:
a. Pico Macom FAM Series.
b. Blonder-Tongue FAF Series.
c. Regal RILA Series.
d. RMS FAP Series.
e. or equal.

E. Splitter/Combiners, 2 to 8 way
1. Drawing Symbol
a. Two Way: SP-2.
b. Three Way: SP-3.
c. Four Way: BBOC4, SP-4.
d. Eight Way: BBOS8, SP-8.
e. Manufacturer, SP-2, SP-4, SP-8
i. Blonder-Tongue DGS Splitters.
ii. Blonder-Tongue SRT Series.
iii. Pico Macom TSB-1G Series.
iv. Regal.
v. or equal.

F. Terminator, 75 ohm, "F" type
1. Manufacturers
a. Blonder-Tongue 4670.
b. Pico Macom F-59T.
c. or equal.

G. In-Line Cable Slope Equalizer

1. Drawing Symbol: TILT
2. Features
   a. Passive network element.
   b. Pass band 5 to 1,000 MHz.
   c. 75 ohm characteristic impedance.
   d. Provide insertion loss versus frequency at approximately the inverse of that for coaxial cable.
   e. Return loss approximately 20 dB.
   f. Available in values of at least 3, 6, 6 and 12 dB of equalization.
   g. Provide the equalization value as indicated in Communications Series Drawings.
3. Manufacturers
   a. Toner Cable Equipment, Inc. XEQ-900-[equalization value].
   b. dB-tronics
   c. Soontai Tech Co., Ltd.
   d. or equal.

2.4 Broadband Miscellaneous Products

A. Connectors; Radio Frequency Broadband
1. Features
   a. "F" Type, size to match cable
   b. 360 degree radial compression.
   c. Pull-out strength not less than 40 pounds.
2. Manufacturers
   a. Thomas & Betts/LRC Snap-N-Seal F Connectors.
   b. Steren/Pico Macom PermaSeal-II F Series Compression Connectors.
   c. Liberty Cable
   d. or equal.

2.5 Cable

A. Broadband Cable
1. Drawing Symbols:
   a. RG-59M
   b. RG-6M, RG6ML
   c. RG-11M
2. Marking and fire resistance:
3. Comply with CEC 820-4 and 820-15.
4. Manufacturer part numbers specified in this paragraph are for listed Type CATV. Provide the listed Type cable as indicated or as required by the condition of placement at no additional cost to the Owner.
5. Approvals
   a. CEC and NEC for application.
   b. SCTE
6. Performance:
   a. RG6ML cabling to be 100% sweep tested by the manufacturer up to 2,200 MHz and shall be listed by the manufacturer as suitable for L-Band Satellite signal distribution. Minimum performance as follows:

Frequency (MHz)	Maximum Nominal Attenuation (dB)
1	0.26
10	0.81
50	1.46
100	2.05
200	2.83
500	4.53
1000	6.59
1450	8.1
1800	8.8
2200	10.1

b. All other cabling to be 100% sweep tested by the manufacturer up to at least 1000 MHz and shall be listed by the manufacturer as suitable for MATV distribution up to 1 GHz, and meet or exceed maximum loss described for RG6ML type up to 1 GHz.

7. Size: Unless otherwise noted or scheduled, size for loss condition and best reasonable economy.

Use	Cable Size
Trunk Feeder	RG-11 size.
Riser Feeder	RG-11 size.
Drop Feeder	RG-6 size.

8. Shield and jacket by placement:

Placement	Shield	Jacket
Antenna and Headend	Quad	PVC
Metallic Raceway	Double	PVC or PE
Not in Raceway (where permitted)	Triple or Hardline	NEC 820-15

9. Manufacturer, triple shield RG6M
   a. Belden 1189A or 1189U
   b. CommScope F6TSVV, F677TSVV
   c. West Penn/CDT T841
   d. Carol/General Cable
   e. Steren
   f. or equal.
10. Manufacturer flooded jacket, quad shield RG6M
   a. Belden 1190A
   b. CommScope F6SSEF
   c. Carol/General Cable
   d. Steren
   e. or equal.
11. Manufacturer L Band RG6ML
   a. Belden
   b. CommScope
   c. Carol/General Cable
   d. Steren
   e. or equal.

12. Manufacturer flooded jacket, quad shield RG11M
    a. Belden 1618A
    b. CommScope F11SSEF
    c. Carol/General Cable
    d. Steren
    e. or equal.

PART 3 - EXECUTION

3.1 General

A. Distribution
1. Install passives and indicated active broadband distribution components on Communications Rooms backboards. Neatly dress and organize work to maximize serviceability and minimize potential for interference with other tradespersons occupying the Communications Room.
2. Maintain indicated hold clears for work of Others.
3. Utilize backboard wiring managers as specified in Section 27 11 23.
4. Label cabling, ports and connectors per Section 27 05 53.
5. Place termination resistors at all unused system terminal points.

3.2 Signal Polarity Convention

A. Maintain consistent absolute signal polarity at all connectors, patch points and connection points accessible in the system.
B. Video and Broadband Connector Convention:

Signal	Connector	Wire
Signal Phase	Center Pin	Center conductor
Signal Anti-Phase	Shell	Shield
Signal Ground	Shell	Shield

3.3 Systems Performance Testing and Adjusting Procedures

A. Passive and Amplification Broadband System
1. Using the specified broadband signal generator and broadband signal level meter, the test equipment manufacturer's procedure and the performance standards of this Section, perform the following tests and adjustments - test and document signal levels at each faceplate scheduled for MATV service:
    a. Sweep installed cabling systems to detect faults due to damaged cabling and mis-installed connectors. Remedy defective conditions before proceeding.
    b. Verify frequency response of cabling.
    c. Apply pads and tilt equalization to balance performance of individual drops as indicated on the system single line diagram.
B. Gain Adjustment.
1. Coordination installation of CATV service at system headend with Owner's franchised CATV provider.
2. Adjust amplifier gain and equalization to match the performance standards defined in 1.4 of this Section.
C. Subjective.

1. Verify subjective picture quality at installed MATV faceplates in the presence of the Owner's Representative of both the Cable Television signal and the Satellite derived channel. For this demonstration, provide a portable cable ready color television and franchised CATV provider Set-top boxes where equivalent systems not already installed at selected locations.

D. Submit Test Report.

END OF SECTION

PART 1 - GENERAL

1.1 Summary

A. Section includes, but is not necessarily limited to:
   1. Common standards and procedures for the Electronic Safety and Security Work.
   2. Design, engineer and provide complete, all means of support, suspension, attachment, fastening, bracing, and restraint (hereinafter "support") of the Work of this Division. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction.
B. Provisions of this Section apply to Electronic Safety and Security Work, including the following Sections:
   1. Section 28 05 26 – Grounding and Bonding for Electronic Safety And Security
   2. Section 28 05 28 – Pathways for Electronic Safety And Security

1.2 References

A. Usage in accordance with Section 01090 - Abbreviations, Symbols & Definitions.
B. Conform to the applicable portions of the following standards agencies:
   1. American National Standards Institute (ANSI)
      a. ANSI C39.1 (1981; R 1992) Requirements for Electrical Analog Indicating Instruments
   2. ASTM International (ASTM)
      a. ASTM A 123/A 123M (2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
      b. ASTM B 32 (2004) Solder Metal
   3. Electronic Industries Alliance (EIA)
      a. EIA ANSI/EIA/TIA-232-F (2002) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
   4. National Electrical Manufacturers Association (NEMA)
      a. NEMA ICS 2 (2000) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC
      b. NEMA ICS 6 (1993; R 2001) Industrial Control and Systems: Enclosures
   5. Society Of Motion Picture And Television Engineers (SMPTE)
      a. SMPTE 170M (1999) Television - Composite Analog Video Signal - NTSC for Studio Applications
   6. U.S. Defense Intelligence Agency (DIA)
      a. DIA DCID 1/21 (1994) Security Guidance and Procedures Physical Security Standards for Sensitive Compartmented Information Facilities
   7. U.S. National Archives And Records Administration (NARA)
      a. 47 CFR 15 Radio Frequency Devices

8. Underwriters Laboratories (UL)
   a. UL 1037 (1999; Rev thru Sep 1999) Antitheft Alarms and Devices
   b. UL 1076 (1995; Rev thru Feb 1999) Proprietary Burglar Alarm Units and Systems
   c. UL 1610 (1998; Rev Aug 2001) Central-Station Burglar-Alarm Units
   d. UL 294 (1999; Rev thru Oct 2001) Access Control System Units
   e. UL 636 (1996; Rev thru Mar 2001) Holdup Alarm Units and Systems
   f. UL 639 (1997; Rev thru Sep 2002) Intrusion Detection Units
   g. UL 681 (1999; Rev thru Jan 2001) Installation and Classification of Burglar and Holdup Alarm Systems
   h. UL 796 (1999; Rev thru Dec 2003) Printed-Wiring Boards (1982 issue or latest revision).

1.3 Definitions

A. See also Section 01090 - Abbreviations, Symbols & Definitions, and Section 27 05 00 – Common Work Results for Communications.

B. General Abbreviations used in these specifications. Refer additionally to the abbreviations list appearing on the Drawings.

1.	ADA	Americans With Disabilities Act.
2.	AFC	Above Finished Ceiling.
3.	AFF	Above the Finished Floor.
4.	BLDG	Building
5.	CAT	Category
6.	CL	Centerline
7.	DIV	Division
8.	(E)	Existing
9.	FBO	Furnished By Owner
10.	HR	Home Run
11.	ID	Inside Diameter
12.	LAN	Local Area Network
13.	MAX	Maximum
14.	NIC	Not In Contract.
15.	OD	Outside Diameter
16.	OFE	Owner Furnished Equipment.
17.	PSRH	Project Standard Receptacle Height.
18.	PSSH	Project Standard Switch Height.
19.	TYP	Typical
20.	UON	Unless Otherwise Noted.

C. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:
   1. Active mode: That in which some type of signal is continuously sent across the link, resulting in simple link breaks being readily detected.
   2. Fail-safe: The capability to monitor system functions and reportan alarm when a failure is detected in a critical system function.

3. Installer: Either the Contractor or a subcontractor with whom the Contractor has a firm contractual agreement.
4. Intruder: An animate object at least 1220 mm 48 inches in height, 34 kg 75 pounds in weight and 4 cubic feet in volume, moving through the protected zones or portals at a velocity of 30 to 3000 mm 0.1 to 10 feet per second.
5. Sensor zone: A geographic position for which an intrusion must be identified and displayed and may be the combination of multiple detection devices.
6. Element: As used in this section means a constituent part of a complex signal such as an AC or DC voltage or current, AC phase, or frequency duration.
7. Secure Side. With respect to a door, the side on which the assets to be protected lie. At exterior doors, this is generally the interior face. Refer to the architectural plans, including the exiting plan, the door hardware schedules and specifications to confirm which face is the Secure Side.
8. Unsecure Side. With respect to a door, the exposed side opposite the side on which the assets to be protected lie. At exterior doors, this is generally the exterior face.
9. Armed. For a given device, failure to operate in a prescribed manner causes an alarm state to be generated at the central alarm monitoring panel or screen, and if a local sounder/door alarm is shown, causes sounder to activate.

1.4 System Performance Requirements

A. Provision of access control system rough in, used in conjunction with devices installed under the work of the Owner's separate contractors, shall enable the following access control and intrusion detection functions.
B. Door Opening Operations. Assumes doors are in armed condition.
1. Doors with Card Reader on One Side
a. Presentation of valid card at unsecure side:
i. Performs realtime lookup of card against current database to validate card status relative to door opening, day of week and time of day.
ii. Provides positive success visual feedback - green light or similar - to card holder
iii. Permits cardholder to operate door.
iv. Logs entry in access database, including at minimum cardnumber, door number and timestamp
v. Shunts alarm generation for door open status for Owner selected variable period (adjustable over a range of at least 10 seconds to 1 minute).
b. If double door opening, permits operation of second leaf during the Owner selected variable period without generating alarm.
2. Presentation of invalid or unreadable card at unsecure side of door:
a. performs realtime lookup of card against current database to validate card status relative to door opening, day of week and time of day.

b. provides positive failed visual feedback - red light or similar - to card holder and denies operation of door.
c. logs entry in access database, including at minimum cardnumber (if readable), door number and timestamp

3. Approach to door from secure side
   a. Doors equipped with Request to Exit: If occupant breaks approach beam from side farthest from door first, followed by beams closer to door, shunts generation of alarm on door operation for Owner selected variable period as for Card Readers above for Owner selected variable period as for Card Readers above (adjustable over a range of at least 10 seconds to 1 minute).
   b. Doors equipped with Release Button: On operating Release Button, shunts generation of alarm on door operation for Owner selected variable period as for Card Readers above .
4. If double door opening, permits operation of second leaf during the Owner selected variable period without generating alarm.
5. Doors with Card Readers on both sides.
   a. Operation, General
      i. Unless otherwise indicated, doors with dual card readers have an unsecure and secure side. Neither magnetic locks nor delayed egress systems are to be installed. A valid card is necessary to operate the door from the unsecure side as for doors with single card readers
      ii. A valid card is necessary to shunt the door alarm when operating the door from the secure side. Failure to present a valid card does not prevent door from operating.
      iii. Presentation of valid card at unsecure side:
         (1) performs realtime lookup of card against current database to validate card status relative to door opening, day of week and time of day.
         (2) provides positive success visual feedback - green light or similar - to card holder
         (3) permits cardholder to operate door.
         (4) logs entry in access database, including at minimum cardnumber, door number and timestamp
         (5) shunts alarm generation for door open status for Owner selected variable period (adjustable over a range of at least 10 seconds to 1 minute).
   b. If double door opening, permits operation of second leaf during the Owner selected variable period without generating alarm.
   c. Presentation of invalid or unreadable card at either side of door:
      i. performs realtime lookup of card against current database to validate card status relative to door opening, day of week and time of day.

ii. provides positive failed visual feedback - red light or similar - to card holder and, at unsecure side, denies operation of door
iii. logs entry in access database, including at minimum cardnumber (if readable), door number and timestamp

d. Presentation of valid card at secure side.
i. performs realtime lookup of card against current database to validate card status relative to door opening, day of week and time of day.
ii. provides positive success visual feedback - green light or similar - to card holder
iii. logs entry in access database, including at minimum cardnumber, door number and timestamp
iv. shunts alarm generation for door open status for Owner selected variable period (adjustable over a range of at least 10 seconds to 1 minute).

e. If double door opening, permits operation of second leaf during the Owner selected variable period without generating alarm.

6. Doors left open ("propped open") beyond the designated period generate an alarm at the central control panel indicating door and condition. If a local door alarm is shown in the vicinity of the door, causes the local door alarm to sound. Local door alarm can be cleared either from the access control system control screen or locally using designated key.
7. Doors operated while armed without presentation of a valid card, valid operation of a Request to Exit Device, operation of a release button or release by central control panel to generate an alarm at the central control panel indicating door and condition. If a local door alarm is shown in the vicinity of the door, causes the local door alarm to sound,. Local door alarm can be cleared either from the access control system control screen or locally using designated key.

C. Access Control and Alarm System - General Requirements:
1. UL Listed 1076 Proprietary Burglar Alarm Unit.
2. Provide for a separate supervised circuit to each monitored device.
3. Monitor circuits at local Data Gathering Panels. Indicate at least:
a. Alarm on contact state change.
b. Trouble on short or open.

D. Uninterrupted Power System: Sustain system operation for 10 minutes, including operation of electric door hardware and monitoring function.

1.5 Submittals

A. Comply with Section 01340 - Shop Drawings, Product Data & Samples and the following.
1. Submit all materials for review arranged in same order as Specifications, individually referenced to Specification Section, Paragraph and Contract Drawing number. Conform in every detail as applies to each referencing Section.
2. Submit 8 ½"x 11" items bound in volumes and drawings in edge bound sets. Submit all drawings on sheets of the same size.

3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.

B. Installer and Key Personnel Experience.
1. A minimum of 30 days prior to installation, submit documentation of the experience of the Electronic Safety and Security installer(s) and of their key personnel.
2. Qualifications shall be provided for:
   a. the Electronic Safety and Security installers,
   b. and the supervisor(s) (if different from the installers).
3. Refer to Quality Assurance paragraph in this section for complete requirements.

C. Manufacturer's Product Data:
1. Manufacturer's Product Data Sheets. Collate in sequence of List of Materials:
2. Data sheet for each item in each Communications Section, including all accessories, clearly marked for proposed product.
3. Material Safety Data Sheet, where applies.
4. List of Materials Schedule. For each item, include:
   a. Referencing Specification Section
   b. Referencing Paragraph
   c. Referencing Drawing, if specified only on plans
   d. Manufacturer.
   e. Model number.
   f. Listing, including name of Nationally Recognized Testing Laboratory.
   g. Precede each submittal book with a summary schedule, with columns for each item above and rows for each item submitted.
      i. Example:

Specification Section	Paragraph	Contract Drawing Reference	Manufacturer	Model No.	UL/ CLA Listed
28 05 00	2.03C		XYZ	123	Y
28 13 00	2.07A1		AAA	34-56	Y
		TY2.1	ZZY	456	Y

D. Functional description, provide
1. A system description, including analysis and calculations used in sizing equipment required.
2. Description to show how the equipment shall operate as a system to meet the performance requirements. The following information shall be supplied as a minimum:
   a. Description of site equipment and its configuration
   b. Protocol description
3. Start up operations
4. System expansion capability and method of implementation
5. System power requirements and UPS sizing

E. Field (Installation) and Shop Drawings: Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Collate in sequence at least the following plans:

1. Drawing index/symbol sheet.
2. Floor plans. At scale of Contract Documents. Show:
   a. Device locations, type and circuit number(s).
   b. Mounting height.
   c. Conduit size.
   d. Rough-in.
   e. Wire type.
   f. Wire fill.
   g. Termination rooms, including BDF and IDF Closets where use of these spaces are indicated on the Bid Documents
3. Sections/Elevations: At scale of Contract Documents:
   a. Mounting location reference.
   b. Terminal cabinets.
   c. Power Supplies and UPS.
   d. Electrical power receptacles required for the work of this Section.
   e. Block wiring terminations
   f. Clearances
   g. Backboard Wire and Cable Management
   h. Copper cable patch panels.
   i. Rack layouts.
4. Enlarged plans. At scale of Contract Documents or larger as required for trade coordination. Show:
   a. Refer to "floor plans" above.
   b. Architectural features.
   c. Rack cabinets.
   d. Clearances required by the CEC.
   e. Terminal panels and backboard mounted power supplies
   f. Terminal blocks
   g. Electrical and Mechanical panels, including panel boards, EMS and fire alarm, and mechanical systems in vicinity of the work of these Sections.
5. System Conduit Riser Drawing. Submit drawings that clearly and completely indicate the function of each Electronic Safety and Security component. Indicate termination points of devices, and interconnections required for system operation. Indicate interconnection between modules and devices. Show:
   a. Terminal cabinets.
   b. Coordination with floor plans.
   c. Wire runs not shown on floor plans.
   d. Wire type.

e. Wire number
f. Wire fill.

6. Single line diagram of Electronic Security and Safety Systems. Indicate the relationship of integrated components on one diagram and show power source, system controls, impedance matches; plus number, size, identification, and maximum lengths of interconnecting wires.
   a. Show at least:
      i. Equipment: Function, make, model.
      ii. Rack number.
   b. Grounding and bonding scheme
   c. Terminal cabinets.
   d. Coordination with floor plans.
   e. Wire runs not shown on floor plans.
   f. Wire fill.
   g. Wire numbers assigned uniquely to each wire/cable.
   h. Wire type.
   i. Signal Type
   j. Signal operating level or voltage (for non-optical communications).
   k. Shield condition at both ends (float, ground, location of ground) for non-optical communications.
7. Equipment rack elevations: All racks scaled at 1-1/2" equals 1 foot, or larger.
   a. Show Equipment:
      i. Function.
      ii. Make.
      iii. Model.
8. Rack wiring drawings: For each rack, show:
   a. Power strip: Receptacles, circuiting.
   b. Equipment.
   c. Grounding.
   d. Wiring, all systems.
   e. Wiring harness scheme.
9. Mounting details:
   a. Specific details of restraints including anchor bolts submitted under the Section 27 05 29 – Hangers and Supports for Communications Systems for mounting and maximum loading at each location, showing compliance and coordination with the CBC and the project Architectural, Structural and Mechanical Documents.
   b. Stamped and signed by an Engineer licensed in the Project jurisdiction for work of this type.
      i. Submit an accompanying Engineering analysis stamped and signed by an Engineer licensed in California for work of this type, indicating that the Equipment Enclosure System will comply with California Building Code for the Project Seismic Zone when loaded with the weight of the equipment submitted.

ii. Show calculations on drawings or in bound volume for review.

c. Show loads, type and strength of connections, sizes, dimensions, materials, etc.

d. Provide details for:

i. Equipment Rack anchorage.

ii. Wall Mounted Racks and Enclosures.

iii. Cable Runway and Cable Tray

iv. Monitors, cameras or other Electronic Safety and Security Equipment with total weight, including housing and support brackets weighing 20 pounds or more.

10. Installation details

a. Terminal cabinets: Draw elevations of terminal blocks corresponding to the Single Line Diagram.

b. Firestopping,

c. Details of flexible raceway connections to be made to vibrating equipment

d. Details of J-Box and sealant application for the typical conditions listed in Section 27 05 48 – Noise and Vibration Controls for Communications Systems.

e. California Access Compliance Manual and Americans with Disabilities Act (ADA) compliance.

11. Fabrication details

a. Receptacles.

b. Panels.

c. Special mounting provisions

d. Legends/engraving details. Half or full size:

12. Schedules of Application

a. An itemized list of all items of equipment to be fitted with flexible electrical connections.

b. Catalog cuts of the products to be applied as J-Box mastic and Acoustical Sealant, and a schedule of rooms to receive application of mastic and sealant at J-Boxes.

F. Test plan

1. Project Site Test Reports:

a. Schedule: Submit test reports in timely manner relative to Project schedule such that the Owner's Representative may conduct verification of submitted test data without delay of scheduled progress.

b. Project Site test report: Submit following system completion and prior to and as condition precedent to Acceptance Review and Testing of the Work of this Section.

c. Content: Include at least:

i. Time and date of test.

ii. Personnel conducting test.

iii. Test equipment, including serial and date of calibration.

iv. Test object.

v. Procedure used.

vi. Results of test

vii. Numerical or graphical presentation.

viii. Electronic file in format and media directed by the Owner's Representative.

d. Refer additionally to the requirements of Part 3 of this Section and of the individual Electronic Safety and Security Sections.

1.6 Quality Assurance

A. Procedures: In accordance with Section 01400 - Quality Control.

B. Qualifications

1. Installer's Qualifications

a. Prior to installation, submit data of the installer's experience and qualifications. Show that the installer who will perform the work has a minimum of 2 years experience successfully installing Electronic Safety and Security Systems of the same type and design as specified herein. Include the names, locations, and points of contact of at least two installations of the same type and design as specified herein where the installer has installed such systems.

b. Indicate the type of each system and certify that each system has performed satisfactorily in the manner intended for a period of not less than 12 months.

2. Instructor's Qualifications

a. Prior to installation, submit data of the instructor's experience and qualifications. Show that the instructor, who will train operating and maintenance personnel, has received a minimum of 24 hours of IDS training from a technical organization such as the National Burglar and Fire Alarm Association, and 2 years experience in the installation of IDS of the type specified.

3. Access Control Systems Contractor and Installation Personnel

a. Contracting firm(s) and installation personnel installing the Software House C-Cure access control systems specified under the work of Division 28 shall be authorized dealers in the specified products.

b. Installation personnel installing the Software House C-Cure access control systems specified under the work of Division 28 shall have received factory training to install and program the specified hardware

C. Designated Supervisor: Furnish a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual through the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

D. Reference Documents: At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies.

1. A complete set of the latest stamped, actioned submittals of record.

2. A complete set of manufacturer's original operation, instruction and service manuals for each equipment item.

E. Test Equipment

1. Requirements:
   a. Maintain and operate test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section.
   b. Maintain test equipment at the job site while work is in progress from installation of equipment racks until Owner Acceptance of this Work; thereafter remove all of this test equipment from the job site.
   c. Unless otherwise indicated, test equipment shall remain property of the Contractor.
   d. Provide all required test cables, jigs and adapters.
   e. Provide equipment with traceable calibration, with calibration date not greater than one year prior to the date of the use of the equipment to perform the specified testing.
2. Equipment: Specified in individual Sections.

F. Standard Products
1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.
   a. Alternative Qualifications. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
2. Material and Equipment Manufacturing Date
   a. Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.7 Regulatory Requirements

A. Regulations Applicable: Including but not limited to those defined in Section 01060 - Regulatory Requirements.
1. Nothing in the Contract Documents shall be construed to permit Work not conforming to applicable laws, ordinances, rules, or regulations.
2. Safety Agency Listing: All devices provided under the Work of this Section which are connected to the Project electrical system shall be listed by a Nationally Recognized Testing Laboratory, and shall be so labeled.
3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in

these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner's Representative. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.8 Delivery, Storage and Handling

A. Procedures:
B. In accordance with Section 01600 - Material & Equipment and as specified in the individual Electronic Safety and Security Systems sections.
C. General
1. Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for cabling and equipment placed in storage.

1.9 Environmental Requirements

A. Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, non-condensing.

1.10 Sequencing

A. Comply with Section 01011 - General Provisions.

1.11 Operating and Maintenance Data

A. Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the Electronic Safety and Security cabling and pathway system. Precede the manuals with a systems narrative specific to this Project, outlining the major systems functionality, the major systems components, and identifying which manuals document the performance of which subsystems.
1. Submit operations and maintenance data in accordance with Division 1 and as specified herein not later than 2 months prior to the date of beneficial occupancy.
B. Spare Parts
1. In addition to the requirements Division 1, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

1.12 Project Record Documents

A. Comply with Division 1, and the following.
1. Record Drawings
a. Content
i. Furnish at least as required for the Shop and Installation Drawings defined elsewhere in this Section.

ii. Contractor shall be responsible for updating building and Electronic Safety and Security plans to reflect as-built conditions.

iii. Indicate actual work on Drawings; indicate actual products used, replace vendor neutral nomenclature used in bid set with makes and models of actual installed devices.

b. CAD.

i. Use a computer aided drafting (CAD) system in the preparation of record drawings for this Project. CAD system shall produce files in AutoCAD® .DWG format, latest release at time of Project bid closure. Campus Standard, no substitution permitted.

ii. Except where prohibited by Contract, Owner's Representative will furnish CAD backgrounds in AutoCAD® .DWG format, for use by the Contractor in preparing Record Drawings.

iii. Disk copy of Record Drawings: Provide 2 separate disc copies of each drawing file in the format noted above. Submit on CD-ROM CD-R format.

c. Reproduceables: As specified in Division 1.

1.13 Warranty Service

A. In addition to provisions of Section 01740 - Guarantees, Warranties, Bonds, Service & Maintenance Contracts, provide the following.

1. Response Time: Provide a qualified technician familiar with the work at the Project Site within 24 hours after receipt of a notice of malfunction. Provide the Owner's Representative with telephone number attended 8 hours a day, 5 days a week, to be called in the event of a malfunction.

B. Furnish all additional Warranties as defined in each Electronic Safety and Security Systems Section.

1.14 Acceptance Review and Testing Procedures

A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Owner's Representative in writing that the Work of these Sections is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing. The Owner's Representative will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These procedures may be performed at any hour of the day or night as required by the Owner's Representative to comply with the Project Schedule and avoid conflict with Residents. Provide all specified personnel and equipment at any time without claim for additional cost or time.

B. Personnel: Furnish services of the designated supervisor and additional technicians familiar with work of this Section. Furnish quantity of technicians as required to comply with Project Schedule.

C. In Addition, Provide:

1. All tools appropriate for performance of adjustment of and corrections to this Work. Include spare wire and connectors and specified tooling for application.
2. Ladders, scaffolding and/or lifts as required to access high devices.
3. All test equipment.
4. Complete set of latest stamped, actioned submittals of record for reference.
5. Complete set of Test Reports.
6. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.
7. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
8. Adjust: As approved by the Owner’s Representative.
9. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the Owner’s Representative.

D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner’s Representative, in place of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven (7) days prior to the scheduled completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

1.15 Closeout

A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify the Owner’s Representative of completion of Punch List.
B. Portable Equipment: Furnish all portable equipment and spares to the Owner’s Representative, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.
C. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.
D. Project Record Documents: Submit print and digital copies. Digital files shall be in AutoCAD .dwg format, latest release at time of Project bidding.
E. Keys: If applicable, replace construction locks with permanent locks. Furnish 5 sets of keys to the Owner’s Representative.
F. Instruction: Conduct specified instruction.
G. Warranty: Submit Warranty dated to run from date of Substantial Completion of the Project.

PART 2 - PRODUCTS

2.1 General

A. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.
B. Each material, device or piece of equipment shall comply with all of the manufacturer's current published specifications for that item.
C. Products shall be made by manufacturers regularly engaged in the production of such products.
D. Provide quantity as shown on Contract Drawings, or as otherwise indicated.
E. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.
F. Unless recycled content is specified, provide new materials.
G. Provide the manufacturer's latest design/model, permanently labeled with the manufacturer's name, model number and serial number.
H. Where products are of similar type or use, provide products of the same manufacturer, unless otherwise indicated.
I. Components
   1. UL or third party certified. Cabling and interconnecting hardware and components for Electronic Safety and Security systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.
   2. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance.
      a. The label or listing by the specified organization will be acceptable evidence of compliance.
      b. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Owner’s Representative.
      c. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
J. Enclosures:
   1. Provide steel frames and enclosures designed and wired to eliminate all induced currents.
   2. Make bolted connections with self-locking devices.
K. Finishes: Any item or component of the Work of this Section which is visible shall comply with the following.
   1. Finishes noted or scheduled on the Contract Drawings take precedence.
   2. Where design location requires that products, materials or equipment are visible to the public, no manufacturer's logos larger than 1/2 inch shall be visible. Unless otherwise noted or directed, neatly remove or

permanently paint out such logos.

3. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Owner's Representative.

2.2 Alarm Sensors & Field Devices

A. General
1. Field devices to be selected to match condition of opening and/or space to be protected. The following specifications are minimum standards; Contractor to consult with listed manufacturers and select appropriate device and mounting means for unusual construction conditions.

B. Door Tamper Alarm Switch
1. Drawing Reference: DS
2. Construction and Features
a. UL Listed
b. Hermetically sealed magnetic reed switch. Dual biased high security switch assembly deters tampering. Reed shall be potted in the contact housing with a polyurethane based compound.
c. Magnet shall be made of Alnico V.
d. Steel Door Switches
i. Contact and magnet housing shall snap-lock into a 3/4" or 1" dia. hole. Snap-lock insulation bushing for tight fit and maximum gap in steel.
ii. Housings shall be molded of flame retardant ABS plastic. Both contact and magnet plastic housings are constructed of one piece of thick-walled ABS plastic for maximum strength.
iii. Color of housings shall be off-white, grey or mahogany brown. Color to be selected by Owner's Representative.
iv. Designed for Use in Steel Doors
v. Operates in steel door and frame at gap up to:
(1) 3/8" min. - 3/4" Doors
(2) ½" min. - 1" Doors
vi. Under Door Threshold switches. At all glass door assemblies with base lock plate, mount DS under door threshold. Provide necessary blocking and shimming and/or secondary magnets at recessed doors to bring magnet within specified gap.
e. Leads:
i. Black: Common
ii. White: Closed Loop
iii. Red: Open Loop
3. Manufacturer:
a. Steel Doors, 3/4"
i. Sentrol 1076CH switch with 1921C magnet.
ii. Or equal

b. Steel Doors, 1"
   i. Sentrol 1076H switch with 1921C magnet.
   ii. Or equal
c. Under threshold:
   i. Sentrol 1921 magnet and 1055 or 1075WSwitch
   ii. Ademco.
   iii. Or equal

C. Local Door Alarm, Interior
1. Drawing Reference: LA
2. Functions/Features:
   a. Provide door management alarms for local and remote monitoring and annunciation of the status of the doors (door prop/door held, door intrusion/door forced or secure)
   b. LDA shall be capable of operating in a stand-alone configuration or with access control systems utilizing a variety of reader technologies: i.e. proximity, Weigand, mag stripe, bar code or biometrics.
   c. Local sounder (field selectable 96 or 103 dBA @ 3 feet) shall be used to indicate both door prop/door held and intrusion/door forced conditions after a user selectable quiet, or access, time (0 seconds - 90 minutes) has expired. Sounder shall be incorporated into the faceplate of the LDA.
   d. Form C (N/O or N/C) contacts shall be available for the following outputs:
      i. Door Contact Status,
      ii. Door Prop Alarm,
      iii. Intrusion & Tamper Alarm
      iv. Bypass/ Key Switch Status.
   e. The alarm (intrusion) contact shall change state upon the recognition of an alarm or tamper condition to alert remote monitoring equipment.
   f. The unit shall remain in alarm until reset by integral key switch, remotely through a dry contact or automatically through an onboard timer (settable from 0 seconds to 5 minutes or manual).
   g. An integral key switch shall be available for alarm shunt or alarm reset and be incorporated into the faceplate of the LDA.
   h. A Bi-Color status L.E.D. shall be incorporated into the faceplate of the LDA. A remote L.E.D. output shall be provided to control a Bi-Color L.E.D. that follows the actions of the faceplate mounted L.E.D.
   i. Inputs shall include a N/C Dry Contact for the door, Voltage Sense (12-24 VAC/DC) to monitor electric lock voltages and a N/O or N/C passive Shunt Input.
   j. The following timers shall be user settable:
      i. Auto-reset,
      ii. Alarm delay
      iii. Silent time
      iv. Shunt Delay.
   k. The LDA shall be mounted in the wall adjacent to the

monitored door at PSSH.

3. Manufacturers:
   a. Designed Security, Inc. Model ES4200 w/ Rim Cylinder Keylock - provide lock to match Owner's approved Master Key System
   b. Detex.
   c. or equal.

D. Request to Exit
1. Drawing Reference: REX
2. Function:
   a. Closure disarms security when approaching door from inside. Omit where base building door hardware incorporates a release button.
   b. Passive infrared technology.
   c. Dual "C" shaped patterns adjustable to limit protection area to areas immediately in front of and to each side of means of approach to protected doors from interior.
      i. ± 14° vertically adjustable pattern.
      ii. Dual C shaped patterns require activation from outside ring (lobby interior) prior to activation from inner ring (adjacent door) to prevent operation of door by sliding object under door from outside of building.
3. Select device and pattern based on mounting height and architectural geometry around door.
4. Finish to be selected by Owner's Representative.
5. Manufacturer:
   a. Detection Systems DS-150i
   b. or equal.

2.3 Power Protection

A. Power Supply, Backboard Mounted
1. Drawing Reference(s): PS, Door Lock Power Supply
2. Backboard mounted equipment
3. Function:
   a. Power supply with backup battery
   b. Class 1 (115VAC Input)
   c. Individually fused, Power Limited, Class 2 outputs - sized to meet worst case load and runtime while maintaining system operations.
   d. Unless otherwise indicated support operations of field devices and doors for at least 10 minutes following loss of power.
   e. Provide timer modules as required to supplement ACAS operations.
   f. Power supply shall accept dry contact interface from fire alarm system to initiate power shutdown to fail-safe electric lock hardware
   g. Battery is lead acid type of common commercial manufacture.
   h. UL Listings: UL 294, UL603, UL 1069, UL1481 for application
   i. Power supply and battery fully enclosed in steel NEMA

enclosure with cam lock cover and conduit knockouts.
j. Thermal and short circuit protection with auto reset.
4. Manufacturers:
a. Altronix AL600ULM.
b. Or equal.

PART 3 - EXECUTION

3.1 Examination

A. Examine existing conditions before starting work. Submit conflicts in a timely manner for resolution

3.2 General

A. Conform to UL 681, UL 1037, and UL 1076, the appropriate installation manual and the requirements of each specification section for each equipment type, whichever is most restrictive . Components within the system shall be configured with appropriate "service points" to pinpoint system trouble in less than 20 minutes.

3.3 Preparation

A. Prepare and sequence the work to minimize disruption to each room environment and any existing Electronic Safety and Security systems.
B. Protection: Cover all computers, electronic equipment, desks, chairs, furniture and other articles when working at ceiling level and/or performing dust producing tasks.

3.4 Repair and Restoration

A. Where working in spaces occupied by the Owner, return to their original positions any furniture or articles relocated to perform the work.

3.5 Cleaning

A. Where working in spaces occupied by the Owner:
1. Immediately after completing work within each space, clean up and remove all materials, scrap and dust.
2. All scrap material in work area shall be picked up and removed from the building at the end of each day. See also Division 1 for additional requirements.
3. All dust resulting from work performed shall be vacuumed up daily.
4. All scrap material shall be removed from Campus and disposed of in an authorized disposal site. Refer to Section 01710 - Clean Up & Disposal for Project procedures.

3.6 Systems Performance Testing and Adjusting Procedures

A. General Procedures

1. It shall be the responsibility of the Contractor to demonstrate to the Owner's Representative that the security system is complete and functional as per these specifications. For intrusion detection field devices test shall ensure that the requisite degree of intrusion detection is provided.
2. Acceptance testing shall be scheduled by the Contractor thorough established project channels
3. Furnish all necessary instruments and equipment required for conducting tests.

B. Device Level Tests
1. Initially, test each sensor and subsystem component individually.
2. Test all wire for shorts, open circuits, or grounding.
3. Immediately correct any defective work

C. Systems Tests.
1. When the function of each component within a particular subsystem such as each sensor within a particular zone is verified, certify that subsystem of the entire Electronic Safety and Security System is satisfactorily meeting required specifications. Test each subsystem similarly until each detection zone has been certified.
2. When subsystem certification is complete, test entire integrated system to ensure that subsystem elements are compatible and function as a complete system. Integrated system test shall be accomplished in linear fashion, end-to-end, and shall verify that each simulated intrusion performed within each detection zone produces an appropriate alarm or signal.
3. Integrated system test shall also verify that alarm is correctly annunciated at the terminal block associated with the field devices,

D. Contractor Testing
1. Provide for approval, not later than 30 days prior to formal inspection and test, a detailed operational test plan of how each component, subsystem, and entire Electronic Safety and Security System will be tested.
2. Submit a written test report from an authorized representative of the equipment manufacturer that the system has been 100% tested and approved. Submit prior to request for final payment.
3. Test each individual circuit and device for proper operation in the presence of telecommunications personnel. Correct all failures and retest at contractors expense to verify corrections. Correct as built drawings, O & M manuals, programming sheets and system programming to reflect the Owner's final occupancy room numbers.
4. Provide Owner's Acceptance Form with a check box associated with each card reader and input point. A check mark in the box will indicate that each point has been correctly installed and that communication between the controller and the server has been established. This form shall be completed prior to Owner acceptance of the system.

3.7 Demonstration of Functionality

A. The Owner's Representative will witness formal tests after receipt of written certification that preliminary tests have been completed and that system is ready for final inspection. Manufacturer's technical representatives shall be present for the final inspection and test. Repeat preliminary tests and functional and operational tests, conducted as requested by the Owner's Representative. Correct defects and conduct additional tests to demonstrate that system conforms to contract specifications.

B. Demonstrate functionality of each installed device is consistent with the read range, sensitivity and immunity to false alarms as specified by the device manufacturer

C. Door Position, Window and Hatch Switches

1. Demonstrate functionality of each device. Demonstrate that operation of each monitored door by 1/2" or less from the fully closed position causes the door position switches to change state.

END OF SECTION

PART 1 - GENERAL

1.1 Scope of Work

A. Section includes grounding and bonding of Electronic Safety and Security Work, including but not limited to:
   1. Electronic Safety and Security Raceways
   2. Cable Shields
   3. Electronic Safety and Security Cabinets and Enclosures.
B. Related Work Under Other Sections
   1. Section 26 05 26 – Grounding Systems
   2. Section 27 05 26 – Grounding and Bonding For Communications Systems
   3. Section 28 05 00 – Common Work Results for Electronic Safety and Security
   4. Section 28 05 28 – Pathway for Electronic Safety and Security

1.2 System Description

A. Provide Electronic Safety and Security Grounding System as described herein and indicated on drawings.
B. Except as otherwise indicated, the complete Electronic Safety and Security installation including the racks, cabinets, panels, cable tray, runway, lightning protectors cable shields and splice cases provided under the work of this project shall be completely and effectively grounded in accordance with all Code and Standards requirements, whether or not such connections are specifically shown or specified.
C. Resistance:
   1. Size TBB per ANSI-J-STD-607-B-2011 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
   2. Resistance from the farthest ground bus through the ground electrode to earth shall not exceed 5 Ohms or the requirements of ANSI-J-STD-607-B-2011, whichever is more restrictive.
   3. Resistance from Electronic Safety and Security Rack Buss ground to Ufer ground must remain less than or equal to the electrical ground presented at A/C outlet for electronic equipment in the Electronic Safety and Security Rack.

1.3 References

A. American National Standards Institute (ANSI)
   1. ANSI-J-STD-607-B-2011 Generic Telecommunications Bonding
   2. and Grounding (Earthing) for Customer Premises
   3. ANSI/TIA-606-B (2012) Administration Standard Telecommunications Infrastructure
B. IEEE
   1. IEEE C135.30 (1988) Standard for Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction
C. Underwriters Laboratories (UL)

1. UL 467 (1993); R 2004 Grounding and Bonding Equipment
2. Underwriters Laboratories (UL).

1.4 Submittals

A. Conform with the requirements of Section 01340 - Shop Drawings, Product Data & Samples and Section 27 05 00 - Common Work Results for Communications.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Ground Bushings, Connectors, Jumpers and Bus:
   1. O-Z/Gedney.
   2. Thomas & Betts Corp.
   3. Or equal.
B. Compression Connector Lug
   1. Panduit
   2. Harger Lightning & Grounding
   3. Or equal.
C. Telecommunications Ground Bus Bar
   1. Panduit
   2. Harger Lightning & Grounding
   3. or equal.
D. Rack and Cabinet Grounding
   1. Panduit Structured Ground Kit
   2. Harger Lightning & Grounding
   3. or equal.

2.2 Ground Conductors

A. General purpose insulated: UL listed and code sized copper conductor, with dual rated THHN/THWN insulation, color identified green.
B. Cable jacket marking:
   1. Must be legible and shall contain the following information:
      a. Manufacturer's name
      b. Copper conductor gauge
      c. UL listing
      d. Cable jacket shall be green with black lettering
C. Telecommunications Bonding Backbone Cable: 3/0 AWG THHN/THWN CU - Must be UL listed.
   1. Manufacturer:
      a. General Cable
      b. Harger Lightning & Grounding
      c. or equal.
D. Bonding pigtails: Insulated copper conductor, identified green, sized per code, and provided with termination screw or lug. Provide solid conductors for #10 AWG or smaller and stranded conductors for #8 AWG or larger.
E. Bonding Conductors sized at 2 kcmil per linear foot of conductor length up to a size of 3/0 AWG ground wire.

2.3 Compression Connector Lug

A. Description
1. Long-barrel compression lugs shall be used on all ground wire.
2. Copper alloy body.
3. Provide lug size to match conductor being terminated.
4. Provide 2 hole pattern lugs.
5. Provide each lug with silicon bronze hardware, including 2 bolts, 2 split lock washers and 2 nuts.

B. Manufacturer:
1. Panduit
2. Harger Lightning & Grounding GECLBxxx (xxx depending on Cable Size)
3. or equal.

2.4 Insulated Grounding Bushings

A. Plated malleable iron or steel body with 150 degree Centigrade molded plastic insulating throat and lay-in grounding lug.

2.5 Connections to Structural Steel, Ground Rods, or Splices

A. Where required by the Drawings or Specifications, grounding conductors shall be spliced together, connected to ground rods or connected to structural steel using exothermic welds or high pressure compression type connectors.
1. Exothermic welds shall be used for cable-to-cable and cable-to-ground rod and for cable to structural steel surfaces. Exothermic weld kits shall be as manufactured by Harger Lightning & Grounding, Cadweld, Thermoweld or equal. Each particular type of weld shall use a kit unique to that type of weld.
2. High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections. Connections shall be as manufactured by Thomas & Betts #53000 series, Burndy “Hy-Ground” or equal.

2.6 Extra Flexible, Flat Bonding Jumpers

A. Two Hole Tinned Flat Braided Copper Ground Straps, 6 Gauge equivalent, 12” long with crimped lugs on each end and ¼”-20 mounting hardware.
1. Manufacturer:
a. Harger GS12094122C3/8
b. or equal.

PART 3 - EXECUTION

3.1 General

A. Provide Grounding and Bonding according to the most restrictive requirements of:
1. ANSI-J-STD-607-B.

2. California Electrical Code Article 250 and references therein.
3. California Electrical Code Article 800.

B. In the event of conflicting requirements, National Electrical Code requirements shall prevail.

C. Point of Connection
1. Under Work of this Section, ground to the building Telecommunications Grounding System as installed under the work of Division 27 at the TMGB

D. Ground And Bonding Conductor Installation
1. All lug connections to the ground bars and opposite end shall use Antioxidant Joint Compound.
2. Unless otherwise noted, all bonding and ground wires on telecom cable trays and runways shall be routed on the outer edge of the cable trays and runways.

E. Mechanical Connections
1. Make connections bare metal to bare metal.
2. Where required, remove paint to bare metal, make grounding or bonding connection, and touch up paint.
3. Torque threaded fasteners to manufacturer's recommended values.

F. Compression Connections
1. Make compression connections with the lug or fitting manufacturer's recommended tooling, with the tooling set to the recommended force and stroke.

G. Electronic Safety and Security Raceways and Sleeves
1. Bond metallic raceway and sleeves to the Telecommunications Ground Busbar at the Telecommunications Room that serves the related Electronic Safety and Security systems.
2. Where a metallic raceway connects 2 or more Telecommunications Rooms, bond to the Telecommunications Ground Busbar at each.

H. Cable Shields
1. Comply with California Electrical Code Article 800.

I. Protector Fields
1. Comply with California Electrical Code Article 800.

J. Electronic Safety and Security cabinets and enclosures
1. Bond to the Communications Ground Busbar at the Communications Room.

3.2 Labeling

A. Provide labeling according to the requirements of:
1. ANSI/TIA-606-B.
2. Section 27 05 53 - Identification for Communications Systems.

END OF SECTION

PART 1 - GENERAL

1.1 Scope of Work

A. Provide electronic security systems pathways as specified in this Section and as shown diagrammatically on the plans. Contractor to design complete Electronic Safety and Security pathway system including provision:
1. Rigid steel conduit and fittings.
2. Intermediate metal conduit and fittings.
3. Electrical metallic tubing and fittings.
4. Flexible metallic conduit and fittings.
5. Liquidtight flexible metallic conduit and fittings.
6. Miscellaneous conduit fittings and products.
7. Junction Boxes
8. Hinged cover enclosures.
9. Pullboxes and Terminal Cabinets.
10. Wireway
11. Strut supports
12. Beam clamps
13. Concrete Fasteners
14. Touch-Up Materials
15. Conduit supports.
16. Equipment supports.
17. Fastening hardware

B. At Hazardous Occupancies, installation conforms to the requirements of California Electric Code for Class and Division rating of spaces.

1.2 Related Work in other Sections

A. Related work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
1. Section 28 05 00 – Common Work Results for Electronic Safety and Security
2. Section 28 05 26 – Grounding and Bonding for Electronic Safety and Security

1.3 System Description

A. Provide devices specified in this Section and related Sections for support of electronic safety equipment specified for this Project.

B. Provide support systems that are adequate for the weight of equipment, conduit and wiring to be supported.

1.4 Seismic Design Requirements

A. Identify each item requiring seismic restraint installation in accordance with CBC Chapter 16A. Include floor mounted items weighing more than 400 pounds and wall mounted or suspended items weighing more than 20 pounds.

B. Supports for such items, including racks, conduit, cable trays and similar shall be provided support, bracing, and anchorage, designed by the Contractor in accordance with the following criteria:

1. Design to resist seismic forces in accordance with CBC Chapter 16A.
2. Minimum Design Parameters - As defined for the Building, with respect to Occupancy Category, Site Classification, Seismic Design Category, Importance Factor, Spectral Acceleration and SDI.

1.5 References

A. Usage: In accordance with Section 01060 - Regulatory Requirements.

B. American Institute Of Steel Construction (AISC)

1. AISC 325 (2005) Steel Construction Manual
2. American National Standards Institute (ANSI)
   a. ANSI C80.1 1994 Rigid Steel Conduit - Zinc Coated
   b. ANSI C80.3 1991 Electrical Metallic Tubing - Zinc Coated
   c. American Society For Testing and Materials (ASTM)
3. ASTM A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4. ASTM A153/A153M-04 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
5. ASTM B633-98e1 Specification for Electro-deposited Coatings of Zinc on Iron and Steel.
6. ASTM A653/A653M-04a Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
7. National Electrical Manufacturers Association (NEMA)
   a. NEMA 250-2003 Enclosures for Electrical Equipment (1000 Volts Maximum)
   b. NEMA FB 1 (ANSI/NEMA FB 1-2003) Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
   c. FB 2.10 2000 Selection and Installation Guidelines For Fittings For Use With Non-Flexible Metallic Conduit Or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, And Electrical Metallic Tubing).
   d. FB 2.20 2000 Selection and Installation Guidelines for Fittings for use with Flexible Electrical Conduit and Cable
   e. NEMA ICS 6 1988 (Rev. 1) Enclosures for Industrial Control and Systems
   f. NEMA OS 3-2002 Selection and Installation Guidelines for Electrical Outlet Boxes.
   g. NEMA RN 1-1998 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal

Conduit.

h. NEMA TC 7 2000 Smooth Wall Coilable Polyethylene Electrical Plastic Duct

i. NEMA TC 13 2000 Electrical Nonmetallic Tubing (ENT).

j. NEMA TC 14 1984(R 1986) Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings

8. Underwriters Laboratories, Inc. (UL)

a. UL 1 2000 Flexible Metal Conduit

b. UL 6 2004 Electrical Rigid Metal Conduit - Steel

c. UL 50 (1995; R 1999, Bul. 2001) Enclosures for Electrical Equipment

d. UL 3601986 (Bul. 1991) (R 1993) Liquid-Tight Flexible Steel Conduit

e. UL 514A 1991 (R 2004) Metallic Outlet Boxes

f. UL 514B 1989 (R 2004) Conduit, Tubing and Cable Fittings

g. UL 514C 1996 (R 2000) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

h. UL 6511989 (R 1989) (Bul. 1993) Schedule 40 and 80 Rigid PVC Conduit.

i. UL 7971993 (R 2004) Electrical Metallic Tubing - Steel

j. UL 1242 1983 (R1993) (Bul. 1993) Intermediate Metal Conduit.

k. UL 1286(1999; R 2001, Bul. 2002) Office Furnishings

l. UL 1479 Fire Tests of Through Penetration Firestops

m. UL Fire Resistance Directories

1.6 Submittals

A. Conform with the requirements of Section 01340 - Shop Drawings, Product Data & Samples and Section 28 05 00 - Common Work Results for Electronic Safety and Security.

1. As part of the project submittals, the contractor to submit engineered shop drawings indicating the proposed design for mounting all work of this Division as defined under the Seismic Design Requirements and defined elsewhere in this Section, inclusive of mounting systems, equipment mounted at the exterior, inclusive of its effective wind load under the range of conditions expected.

a. Shop drawings to be accompanied by anchorage calculations indicating that it shall remain attached to the mounting surface after experiencing forces in conformance with California Code of Regulations, Title 24, California Building Code.

b. Structural Calculations shall be prepared and signed by a California Registered Structural Engineer. Specify proof loads for drilled-in anchors, if used.

1.7 Quality Assurance

A. All materials, equipment and parts comprising the units specified herein shall be new and unused, and of current manufacturer.

B. Only products and applications listed in this Section may be used on the project unless otherwise submitted and approved by the Owner's Representative.

PART 2 - PRODUCTS

2.1 General

A. Provide the following types of conduit systems listed by their commonly used generic name.

2.2 Raceway

A. Manufacturers:
1. Raceway:
a. Allied Tube and Conduit Co.
b. Triangle PWC, Inc.
c. Western Tube and Conduit Corp.
d. Spring City Electrical Manufacturing Co.
e. Occidental Coating Co. (OCAL).
f. Alflex Corp.
g. American Flexible Metal Conduit Co.
h. Anaconda.
i. or equal.
2. Fittings:
a. Appleton Electric Co.
b. OZ/Gedney.
c. Thomas & Betts Corp.
d. Spring City Electrical Manufacturing Co.
e. Occidental Coating Co. (OCAL).
f. Carlon.
g. or equal.

B. Rigid Steel Conduit.
1. Drawing and Spec Reference: RSC.
2. Construction:
a. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and UL 6.
b. Standard threaded couplings, locknuts, bushings, and elbows: Only materials of steel or malleable iron are acceptable. Locknuts shall be bonding type with sharp edges for digging into the metal wall of an enclosure.
c. Three piece couplings: Electroplated, cast malleable iron.
d. Insulating bushings: Threaded polypropylene or thermosetting phenolic rated 150 degree C minimum.
e. Insulated grounding bushings: Threaded cast malleable iron body with insulated throat and steel "lay-in" ground lug with compression screw.
f. Insulated metallic bushings: Threaded cast malleable iron body with plastic insulated throat rated 150 degrees C.
g. All fittings and connectors shall be threaded.

C. Coated Rigid Steel Conduit:
   1. Drawing and Spec Reference: CRSC.
   2. Conduit: Full weight, threaded, hot-dip galvanized steel, conforming to ANSI C80.1 and NEMA RN-1 with nominal 40 mil thermoplastic vinyl coating, heat fused and bonded to the exterior of the conduit.
   3. Fittings:
      a. Conduit couplings and connectors shall be as specified for galvanized rigid steel conduit and shall be factory PVC coated with an insulating jacket equivalent to that of the coated material.
      b. Fittings over-sleeve to extend 1 conduit diameter or 1-1/2" beyond fitting, whichever is less.
   4. Performance:
      a. Tensile Strength: 3500 psi.
   5. Approvals:
      a. NEMA RN1 (Type 40 - 40 mils thick)
      b. CalTrans Type 2
   6. Manufacturers:
      a. Plastibond by RobRoy Industries.
      b. Occal-40 by Occidental Coating Company.
      c. KorKap by Plastic Applicators.
      d. Ocal-Blue
      e. or equal.

D. Intermediate Metal Conduit
   1. Drawing Reference: IMC
   2. Conduit: Hot dip galvanized steel meeting the requirements of CEC Article 345 and conforming to ANSI C80.6 and UL 1242.
   3. Fittings: Conduit couplings, connector and bushing shall be as specified for galvanized rigid steel conduit. Integral retractable type IMC couplings are also acceptable.

E. Electrical Metallic Tubing.
   1. Drawing and Spec Reference: EMT.
   2. Conduit: Shall be formed of cold rolled strip steel, electrical resistance welded continuously along the longitudinal seam and hot dip galvanized after fabrication. Conduit shall conform to ANSI C80.3 specifications and shall meet UL classifications.
   3. Raintight compression couplings: Electroplate steel or cast malleable iron; UL listed raintight and concrete tight, using gland and ring compression type construction.
   4. Raintight compression connectors: Electroplated steel or cast malleable iron, UL listed raintight and concrete tight, with insulated throat, using gland and ring compression type construction.
   5. Use of set-screw couplings and connectors is not permitted.

F. Flexible Conduit:
   1. Drawing Reference: FLEX
   2. Construction:
      a. Flexible steel, zinc coated on both inside and outside by hot-dipping process.
      b. Interlocking spirally wound continuous steel strip.
      c. 3/4" minimum size.

3. Fittings: Connectors shall be of the single screw clamp variety with steel or cast malleable iron bodies and threaded male hubs with insulated throats. Exception: Pressure cast screw-in connectors shall be acceptable for fixture connection in suspended ceilings and cut-in outlet boxes within existing furred walls.
4. Approvals:
   a. UL 1

G. Liquidtight Flexible Metallic Conduit
1. Drawing Reference: Liquidtight
2. Conduit: Shall be fabricated in continuous lengths from galvanized steel strips, interlocking spirally wound, covered with extruded liquidtight jacket of polyvinyl chloride (PVC) and conforming to UL 360. Provide conduit with a continuous copper-bonding conductor wound spirally between the convolutions.
3. Fittings: Connector body and gland nut shall be of cadmium plated steel or cast malleable iron, with tapered, male, threaded hub; insulated throat and neoprene "O" ring gasket recessed into the face of the stop nut. The clamping gland shall be of molded nylon with an integral brass push-in ferrule.

2.3 Miscellaneous Conduit Fittings and Products

A. General
1. UL 514B.
2. Listed in UL Electrical Construction Materials List.

B. Conduit Fittings, Insulated Throat Grounding Bushings
1. Description
   a. Threaded for Rigid Steel Conduit and Intermediate Metal Conduit.
   b. UL Listed for use with copper conductors.
   c. Thermoplastic insulated liner for 105 degrees Celsius.
   d. Body of malleable iron, zinc plated; or die cast zinc.
2. Manufacturer
   a. Thomas & Betts (Steel City) BG-801 Series
   b. O-Z/Gedney
   c. or equal.

C. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.

D. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.

E. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL listed for wet or dry locations.

F. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate .75-inch deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless steel jacket clamps. Unit shall comply with UL467 and UL514.
   1. Manufacturer:
      a. OZ/Gedney Type DX
      b. Steel City Type EDF
      c. or equal.

G. Fire rated penetration seals:
   1. UL classified.
   2. Conduit penetrations in fire rated separation shall be sealed with a UL classified assembly consisting of fill, void or cavity materials.
   3. The fire rated sealant material shall be the product best suited for each type of penetration, and may be a caulk, putty, composite sheet or wrap/strip.
   4. Penetrations of rated floors shall be sealed with an assembly having both F and T ratings at least equal to rating of the floor.
   5. Penetrations of rated walls shall be sealed with an assembly having an F rating at least equal to the rating of the wall.

H. Standard products not herein specified:
   1. Submit for review a listing of standard electrical conduit hardware and fittings not herein specified prior to use or installation, i.e. locknuts, bushings, etc.
   2. Listing shall include manufacturers name, part numbers, and a written description of the item indicating type of material and construction.
   3. Miscellaneous components shall be equal in quality, material, and construction to similar items herein specified.

I. Hazardous area fittings: UL listed for the application.

2.4 Junction and Device Boxes

A. Junction and Device Boxes
   1. Drawing References: As shown on Symbol Schedule
   2. Construction:
      a. Concealed/Flush Mounted:
      b. One or two piece welded knockout boxes.
      c. UL 514A, cadmium or zinc-coated 1.25 oz/sq. ft., if ferrous metal.
      d. Pressed sheet steel, for indoor locations.
      e. UL 514C approved if non-metallic.
      f. At hollow masonry, tile walls and plaster walls, provide with device rings as required.
      g. Surface mounted:
         i. Exterior - Conform to the Junction and/or PullBox construction scheduled on the Plans. Where construction not otherwise scheduled or noted on the plans, conform to the following.:

(1) Cast iron or aluminum with threaded hubs and mounting lugs.
(2) Gasketed cover with spring lid.
ii. Concrete floor embedded:
(1) Cast iron concrete pour boxes with screwed brass cover, unless otherwise noted.
(2) Cadmium plated screw cover attachment at least 6" on center.
h. If size not otherwise noted, at least 4S (4" square) by 2-1/8" deep, or Code minimum size, whichever is larger.
i. Wherever 4S is indicated, contractor may at their option substitute 4-11/16" square boxes while maintaining the minimum depth required by these specifications and the drawings.
ii. At recessed masonry wall installations, provide gangable masonry boxes.
i. Provide complete with approved type of connectors and required accessories, including attachment lugs or hangers. Provide raised device covers as required to accept scheduled device.
3. Approvals.
a. UL 514A
4. Manufacturers:
a. Interior:
i. Steel City.
ii. Bowers
iii. Randl Industries, Inc. (5S Boxes).
iv. or equal.
b. Interior, 5S Boxes
i. Randl, Inc. 5 Square Telecommunications Boxes
ii. or equal.
c. Exterior, exposed with cover of same construction.
i. Appleton
ii. Pyle-National
iii. or equal.
d. Other conditions:
i. Any approved by the Owner's Representative.

2.5 Cabinets and Enclosures

A. Terminal Cabinets:
1. Drawing Reference: As Scheduled.
2. Construction:
a. Zinc Coated Sheet Steel, code gauge with standard concentric knockouts for conduit terminations.
b. Interior dimensions not less than those scheduled.
c. Finish: Manufacturer's standard gray baked enamel finish.
d. Covers: Trim fitted, continuous hinged steel door, flush catch – lockable and keyed to match. Screw fastened doors not acceptable.

i. Door face to be not less than 95% of panel interior dimensions.
e. Provide with 3/4" fire retardant treated ply backboard.
3. Mounting:
a. Flush cabinets shall be furnished with concealed trim clamps and shall be not less than 4 inches deep.
b. Surface cabinets shall be furnished with screw cover trim, flush hinged door and shall not be less than 6 inches deep.
c. Interior Applications:
i. NEMA 250 Type 1, unless otherwise noted. Refer to plans and schedules.
d. Exterior Applications:
i. NEMA 250 Type - As Scheduled, not less than NEMA 3R.
4. Manufacturers:
a. B-Line Electrical Enclosures
b. Circle AW Products.
c. Hammond
d. Henessey.
e. Hoffman.
f. Myers Electric Products
g. Rittal.
h. or equal.

2.6 Wireway

A. Lay-In Wireway
1. Drawing Reference: Gutter
2. Features/Functions/Construction
a. NEMA Type 1, unless otherwise noted.
b. ANSI 61 Gray polyester powder finish inside and outside.
c. Screw fastened cover completely removable to provide complete access to interior.
d. 6"x6" cross-section minimum, size for 30% fill maximum
3. Approvals
a. UL 870
b. NEMA Type 1
4. Manufacturers
a. Hoffman Lay-In Type 1 Wireway
b. Square D
c. Circle AW
d. or equal

2.7 Supporting Devices

A. General
1. Supports to be sized to suit load and selected to match mounting conditions
B. Manufacturers
1. Equal products by the following manufacturers will be considered

providing that all features of the specified product are provided:

a. Concrete fasteners:
   i. Phillips "Red-Head".
   ii. Remington.
   iii. Ramset.
   iv. Hilti
   v. Simpson Strong-Tie
   vi. or equal.

b. Concrete inserts and construction channel:
   i. Unistrut Corp.
   ii. GS Metals "Globe Strut."
   iii. Thomas & Betts "Kindorf" Corp.
   iv. Or equal.

c. Conduit straps:
   i. O-Z/Gedney.
   ii. Erico "Caddy" Fastening Products.
   iii. Thomas & Betts "Kindorf" Corp.
   iv. Or equal.

d. Beam Clamps
   i. Cooper B-Line
   ii. SuperStrut
   iii. Unistrut
   iv. or equal

e. Aircraft Cable Sway Braces
   i. Mason Industries
   ii. M.W. Sausse/Vibrex
   iii. Loos & Company, Inc.
   iv. or equal.

C. Concrete Fasteners
   1. Provide expansion-shield type concrete anchors.
   2. Provide powder driven concrete fasteners with washers. Obtain approval by Owner's Representative prior to use.

D. Concrete Inserts
   1. Provide pressed galvanized steel, concrete spot insert, with oval slot capable of accepting square or rectangular support nuts of ¼ inch to ½ inch diameter thread for rod support.

E. Aircraft cable sway braces
   1. Steel rope sized to meet load.

F. Construction Channel:
   1. Construction:
      a. 1-5/8" square galvanized channel formed from U.S.S.G No. 12 or 0.109 inch cold formed steel with 17/32-inch diameter bolt holes, and 1-1/2 inch on center in the base of the channel.
      b. 10 foot sections.
   2. All supporting materials by same manufacturer.

G. Beam Clamps
   1. Malleable iron electro-galvanized steel beam clamps selected to match building structural steel members.

H. Conduit Straps
   1. One hole strap, steel or malleable iron, with malleable iron clamp-

back spacer for surface mounted wall and ceiling applications.
a. Use malleable strap with spacers for exterior and wet locations.
b. Use steel strap without spacers for interior locations.
2. Steel channel conduit strap for support from construction channel.
3. Steel conduit hanger for pendant support with threaded rod
4. Steel wire conduit support strap for support from independent #12 gauge hanger wires.

I. Threaded rods, couplings, screws and nuts:
1. Electrolytically coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

J. Miscellaneous Parts
1. Hot dipped galvanized after fabrication; after cutting, de-burring and hole drilling. Coated with zinc, 2 oz. zinc per square foot of surface, ASTM A123 or A153.

K. Paint/Tape for Touch-up:
1. Zinc: CRC "Zinc-It", Glyptal, Enterprise Galvanizing “Galambra”, or equal.

PART 3 - EXECUTION

3.1 General

A. The Owner's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the Owner.

3.2 Examination

A. Thoroughly examine site conditions for acceptance of supporting device installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.3 Preparation

A. Coordinate size, shape and location of concrete pads required for equipment installation with the work specified in other sections.
B. Lay out support devices to maintain headroom, neat mechanical appearance and to support the equipment loads.
C. Where shown on the Drawings or Specifications, install freestanding Electronic Safety and Security equipment on concrete pads.

3.4 Conduit Application

A. General: Install the following types of conduits and fittings in the locations listed, unless otherwise noted in the drawings:
1. Exterior, Exposed:
a. Type RSC in conformance with SFIA TIG Sec. 508.7.D(1).
2. Interior, Exposed, Wet and Damp Locations:

a. Type RSC.
b. At interior locations over 8 feet above finished floor, EMT acceptable.

3. Interior, Hazardous Locations
   a. Type RSC
   b. Type IMC, where permitted by the CEC.
4. Interior, exposed or concealed, dry locations:
   a. RSC, if subject to physical abuse.
   b. EMT, if not subject to physical abuse.
5. Interior, concealed, damp locations, including in masonry walls.
   a. RSC
6. Embedded in Concrete
   a. RSC or rigid non-metallic conduit.
   b. PVC Type Schedule 40.
7. Transition from walls, floor boxes and monuments to open plan furniture systems:
   a. Liquidtight

3.5 General Requirements

A. Refer to the manufacturer's instructions and conform thereto.
B. Distribution Pathway via EMT Raceway:
   1. EMT conduit is to be installed meeting the NEC handbook Article 348 Installation Specifications.
   2. Provide escutcheon plates for all through wall conduit stubs.
   3. All ends of conduits shall be cut square, reamed and fitted with insulated bushing.
   4. All conduit which passes through fire walls shall be sealed with fire stop putty after all station wire has been installed.

3.6 Mounting and Installation – Device Boxes

A. Conform to the more restrictive of NEMA OS 3-2002 and the following.
B. Provide backboxes at all Electronic Safety and Security systems devices. Installation of device plates directly to wall surface without use of a backbox, unless specifically directed on plans, is unacceptable.
C. The distance between pull boxes shall not exceed 150 feet or more than two 90 degree bends.
D. Align boxes plumb with floor and surrounding construction. At door frames, locate 4" from frame. Verify placement with Owner’s Representative details to ensure that box clears all trim, etc.
E. Support and fasten boxes securely. At stud walls use rigid bar hangers, attached to hanger with stud and nut.
F. At existing locations, provide cutting, patching and finishing as required to maintain or restore finishes so that resulting installation is integrated into the Architectural decor of the particular location.
G. Mounting Height: the mounting height of a wall-mounted outlet box is defined as the height from the finished floor to the horizontal center line of the cover plate.

H. Mount outlet boxes with the long axis vertical. Three or more gang boxes shall be mounted with the long axis horizontal.
I. Install wiring jacks and outlet devices only in boxes which are clean; free from excess building materials, dirt, and debris.
J. Install wiring jacks and outlet devices after wiring work is complete.

3.7 Terminal Cabinets, Junction Boxes and Pull Boxes

A. General
   1. Thoroughly examine site conditions for acceptance of cabinets and enclosures installation to verify conformance with manufacturer and specification tolerances. Do not commence with installation until all conditions are made satisfactory.
B. Set cabinets and enclosures plumb and symmetrical with building lines. Furnish and install all construction channel bolts, angles, etc. required to mount all equipment furnished under this Section of the Specifications.
C. Cabinets and enclosures shall be anchored and braced to withstand seismic forces calculated in accordance with standards referenced in Section 27 05 29 – Hangers and Supports for Electronic Safety and Security Systems.
D. "Train" interior wiring, bundle and clamp using specified plastic wire wraps. Separate power and signal wiring.
E. Replace doors or trim exhibiting dents, bends, warps or poor fit that may impede ready access, security or integrity.
F. Terminate conduit in cabinet with lock nut and grounding bushing.
G. Cleaning
   1. Touch-up paint any marks, blemishes or other finish damage suffered during installation.
   2. Vacuum clean cabinet on completion of installation.

3.8 Support

A. Provide supports for raceways as specified in this Section.
B. All raceways installed in exposed dry locations shall be grouped in a like arrangement and supported by means of conduit straps, wall brackets or trapeze hangers in accordance with Code and the requirements of this Section. Fasten all hangers from the building structural system.
C. Provide supports and mounting attachments per the most restrictive of Code and the following.

D.

Raceway Size (inches)	No of cables in run	Location	Support Spacing (feet)	
			RSC	EMT
Horizontal Runs				
½, 3/4	1-2	Flat Ceiling Wall Runs	5	5
½, 3/4	1-2	Where Access Limited To Building Structure	7	7
½, 3/4	3≥	Any Location	7	7
1≥	1-2	Flat Ceiling Or Wall	6	6
1≥	1-2	Where Access Limited To Building Structure	10	10
1≥	3≥	Any Locations	10	10
Any	Any	Concealed	10	10
Vertical Runs				
½, 3/4	Any	Exposed	7	7
1, 1-1/4	Any	Exposed	8	8
1-1/2≥	Any	Exposed	10	10

E. Install no more than one coupling or device between supports.

F. The Owner's Representative reserves the right to request additional supports where in their sole opinion said supports are required. Any additional supports shall be installed at no additional cost to the Owner.

3.9 Penetrations

A. Gypsum Wall Board Penetrations: Provide circular penetrations maximum 1/8" inch larger than outer diameter of conduit being used. On both sides of the wall fill space between conduit and wall with joint compound, depth to match gypsum board thickness.

B. Install UL listed fire-stop system whenever a raceway penetrates a firewall in conformance with the manufacturer’s directions, the published systems assembly requirements, CBC Section 709 and 710 and CEC 300-21, whichever is the most restrictive. At cable tray penetrations, provide pillow type removable fire stop per CBC Section 709 and 710, the published systems assembly requirements and the manufacturer’s directions, whichever is the most restrictive.

C. All Electronic Safety and Security systems conduit openings in walls and floors are the responsibility of the Contractor. Install sleeves shown on the drawings when the concrete is poured. Any openings required after the concrete has set maybe core drilled.

3.10 Raceway Installation

A. Access control and intrusion detection systems shall be installed in entirely in raceway sized for 30% cable fill maximum, including:
   1. Rough-in for the field devices as detailed and scheduled on the plans.
   2. Pull cabinets located at regular intervals in the building, sized to accommodate the access control and intrusion detection cabling.

a. Size raceway between pull cabinets to accommodate fill of field devices.
b. Provide two separate raceway systems
i. one for power cabling, including power for door locks and field devices.
ii. one for Access Control and Intrusion Detection System field devices, including card readers, motion detectors, glass break sensors, request-to-exit sensors and similar.

3. Wireway at backboard of BDF and IDF to terminate the raceway arriving from the pull cabinets and directly from the field devices.
4. Terminal cabinets at backboard of BD and IDF to enclose the TB15's used to terminate the field wiring installed under the work of this contract.

B. General
1. Raceway runs are shown schematically – Contractor to provide design and implementation of complete pathway system. Install concealed unless specifically shown otherwise. Supports, pull boxes, junction boxes and similar generally not indicated. Provide where designated in addition to those required by the Contractor's design.
a. Install exposed conduit and raceway parallel and perpendicular to nearby surfaces or exposed structural members, and follow the surface contours. Level and square conduit and raceway runs.
b. Raceway runs shall be mechanically and electrically continuous between all each equipment rack and utility demarcation point, receptacle and/or surface raceway strip, as applies.
c. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box, or outlet by means of a locknut on the outside and a bushing on the inside or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter.
d. Bends
i. All bends or elbows shall have a minimum radius as follows:

Conduit Size	Min. Radius (Inches)
3/4"	8
1"	12
1-1/4"	18
2"	24
2-1/2"	24
3"	30
3-1/2"	30
4"	30
5"	36
6"	42

(1) Use factory elbows or machine bends for conduit bends 1-1/4" and larger.

e. Make bends and offsets so the inside diameter is not effectively reduced. Make bends in parallel or banked runs from the same center line so that the bends are parallel.

f. Install at least one (1) 3/8", 200 pound strength nylon pull cord in all empty raceways.

g. Raceways crossing building expansion joints or in straight runs exceeding 100 feet shall be provided with UL listed expansion fittings.

h. Install conduit seals and drains to prevent accumulated moisture in conduits from entering Electronic Safety and Security Systems enclosures.

2. Do not install conduit in concrete slabs unless specifically directed by Owner's Representative. Embedded conduits in concrete slab walls, and columns shall be installed in center third between upper and lower layers of reinforcing steel as directed by the Owner's Representative. Space conduits 8" on center except at cabinet locations where slab thickness shall be increased as directed by the Owner's Representative.

3. All conduits to be kept 12" away from steam or hot water lines. Install horizontal conduit and raceway runs below water and steam piping.

4. Conduit dropping down to equipment shall be as straight as possible without any offsets, parallel or perpendicular to walls, ceilings and other building features.

5. Conduit installed on any equipment shall be run symmetrical with the equipment and in such a manner as to:

   a. not to be exposed to damage;

   b. not interfere with access to components of the equipment that will interfere with maintenance operation or;

   c. not to be in a manner that the Owner deems detrimental to its operation.

6. Whenever an installation such as that listed occurs, the Contractor shall make all necessary changes at no additional cost to the Owner.

7. All cut ends of conduit, scratches, tool marks, etc. on any metallic raceway installed in the ground or on the exterior of the building shall be treated with two coats of specified Touch Up Paint/Tape.

8. Exposed conduit and metallic surface raceway installed in finished spaces shall be painted to match surrounding surfaces using paint and methods directed by the Owner's Representative.

9. All raceways stubbing up into equipment or racks shall be sealed. Raceways with conductors shall be plugged with duct-seal. Spare raceways shall be capped. Prevent foreign matter from entering conduit and raceway; use temporary closure protection. Replace conduits containing concrete, varnish or other foreign material.

10. Complete installation of conduit and raceway runs before starting installation of cables/wires within conduit and raceway.

11. Use specified conduit and raceway fittings that are of types

compatible with the associated conduit and raceway and suitable for the use and location. Join and terminate conduit and raceway with fittings designed and approved for the purpose of the conduit and raceway system and make up tight.

12. Where chase nipples are used, align the raceway and coupling square to the box and tighten the chase nipple so no threads are exposed.
13. Horizontal conduit or EMT runs, where required and permitted, shall be installed as close to ceiling or ceiling beams as practical.
14. Conduit and EMT connected to wall outlets shall be run in such a manner that they will not cross water, steam or waste pipes or radiator branches.
15. Conduit and EMT shall not be run through beams, purlins or columns except where permission is granted by Owner's Representative in writing.
16. Bond installed metallic raceway in accordance with the requirements of the CEC.

3.11 Raceway for Access Control and Intrusion Detection Systems

A. Refer to general requirements herein above.

B. Access control and intrusion detection systems shall be installed in entirely in raceway below ceiling line in pathway size for 40% fill maximum, including:

1. Rough-in for the field devices as detailed and scheduled on the plans. Extend rough in raceway to the nearest basket tray as shown on the TN plans.
2. Pull cabinets located at regular intervals in the building, sized to accommodate the access control and intrusion detection cabling.
   a. Size raceway between pull cabinets to accommodate fill of field devices.
   b. Pathway including flexible metal and armored cable shall terminate in the sensor or device enclosure.
   c. Ends of conduit shall be fitted with insulated bushings. Provide continuous complete non-flexible pathways, from device, including pull boxes for all field devices. Leaving exposed conductors at ends of conduits external to sensors and devices not acceptable except above accessible ceiling line.
3. Gutter at backboard indicated security electronics termination points sized for 30% fill maximum, to terminate the raceway arriving from the pull cabinets and directly from the field devices pathway systems.
4. Terminal cabinets at backboard of indicated termination rooms for security electronics to enclose the TB15's and terminal blocks used to terminate the field wiring installed under the work of this contract.

3.12 Hazardous Locations

A. Use rigid steel conduit only.

B. Install UL listed sealing fittings that prevent passage of explosive vapors in accordance with the manufacturers written instructions. Locate fittings at suitable, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank coverplate having a finish similar to that of adjacent plates or surfaces.

C. Install raceway sealing fittings at the following points and elsewhere as indicated:
   1. Where conduits enter or leave hazardous locations.

3.13 Reuse of Existing Conduit

A. General
   1. Existing conduit is to be used as a pathway only where so shown on the drawings.
   2. Prior to beginning work involving the use of an existing conduit, the Contractor shall consult with the Owner's Representative in order to establish whether or not the conduit contains active service.
   3. If no active service exists within the conduit, all cable is to be removed, and work is to proceed.
   4. If active service does exist within the conduit and it has been determined that service needs to be disrupted, then work on that conduit shall not proceed until a schedule of service outage has been established by Owner's Representative. Once given direction to proceed, the Contractor shall within the time period of one (1) working day; remove the old cable, install, terminate and test the new cables, and notify the Owner's Representative the work using the specific conduit has been completed. The Owner's Representative shall be responsible for the disconnection and reconnecting of the active service cross-connects within the terminal closet(s).

B. Conduit preparation procedure:
   1. Remove existing wires and cables (if any).
   2. Run a mandrel ½" smaller than the inside diameter of the conduit through the conduit receiving new wires and cables.
   3. If the specified size mandrel will not pass through the existing conduit, start with a smaller size mandrel and increase mandrel size until the specified sized mandrel will pass.
   4. Run a wire brush and clean rag with an outside diameter 1/8" larger than the inside of the conduit through the conduit receiving new wires and cables.
   5. Repeat above until conduit is clean and materials detrimental to the wire and cables to be installed no longer exit conduit with the clean rag.

3.14 Wireway Installation

A. Install complete wireway system at electronic security systems backboards, including track, cover plate, device boxes, inside and outside elbows, splice plates, T's, transitions and extension rings and end caps as required.

B. Any existing surface raceway and/or exposed cabling along the indicated pathway of the raceway to be installed shall be removed prior to the installation of the new raceway. If the existing cabling contains active service, then Contractor shall consult with the Owner's Representative as to how best maintain the existing service before proceeding with the work.

C. Provide and install the proper factory fabricated corners, support clips, end connectors, etc. as required.

D. Corners and joints are to be cut neatly and finished using connector components of specified system. Where components are not available using specified system, to meet requirements of drawings, provide cleanly mitered joints, EMT and/or surface backboxes specified elsewhere herein.

E. All installed surface raceway shall be inspected for marks, scratches, gaps between sections or improper fitting of connector parts. All such damage shall be repaired to the Owner's Representatives satisfaction, or the raceway shall be removed and replaced.

F. Remove sharp corners and edges prior to installation of cable.

G. Attachment of raceway to walls, floors, and partitions:

1. Attach raceway to the supporting surface with mechanical fasteners applied to building structure per the most restrictive of manufacturer's directions, Code, or these provisions.
2. All surface raceway shall be installed so that its edges are parallel to the vertical or horizontal edge of the surface on which they are mounted. All surface raceway, found not to be installed in this manner, shall be removed and re-installed correctly.
3. Surface raceway shall be secured at 2'-0" intervals (2 spaced screws for 2" and wider raceways) with wood screws into wooden framing or self drilling wall anchors (ITWBildex "Heavy Duty E-Z Toggle" or equal) into sheetrock or plastic inserts with pre-assembled drive screw for concrete (ITT-HOLUB "HI-DRIVE" nail anchors or equal) Powder (explosive charge) driven anchors are not acceptable. The use of adhesives as the sole means for fastening to any surface is not allowed.
4. Screws used in fastening surface raceway shall be no less than 3/4" in length.
5. The proper support clips, as called for by the manufacturer, for securing surface raceway to walls or floors are to be used per the manufacturer's instructions.

3.15 Support Installation

A. Furnish and install supporting devices as noted throughout the Electronic Safety and Security Systems work.

B. Electronic Safety and Security device and conduit supports shall be independent of all other system supports that are not structural elements of the building, unless otherwise noted.

C. Fasten hanger rods, conduit clamps, outlet and junction boxes to building structure using powder actuated tools, precast inserts, expansion anchors, preset inserts or beam clamps.

D. Use powder actuated tools, self-drilling anchors, expansion anchor, or preset inserts on concrete surfaces.

E. Use sheet metal screws in sheet metal studs and wood screws in wood construction.
F. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or acoustical ceiling suspension wires.
G. Do not drill structural steel members unless first approved in writing by the Owner's Representative.
H. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
I. Install surface-mounted cabinets with minimum of four anchors. Provide additional support backing in stud walls prior to sheet rocking as required to adequately support cabinets and panels.
J. Bridge studs top and bottom with channels to support flush mounted cabinets and panelboards in stud walls.

3.16 Erection of Metal Supports

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
B. Field Welding: Comply with AWS "Structural Welding Code."

3.17 Wood Supports

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

END OF SECTION

SECTION 28 31 01

FIRE ALARM SYSTEM

GENERAL

1.01 DESCRIPTION:

A. This project shall include the furnishing, installation, connection, programming, commissioning, and testing of new networked fire alarm equipment required to form a complete coordinated system ready for operation at the project. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, networked control panels at each building, auxiliary control devices, annunciators at each building, power supply extender panels (as required), and all associated wiring (fiber optic network loop and copper system cabling).

B. The system shall generally consist of fire alarm control panels at each building, as shown on the drawings, to locally control and operate all initiation and notification appliances at each building. Each panel shall be identified for the specific building it controls and shall include a digital dialer with off-site monitoring connection in order to identify the specific building to the Fire Department. Each building shall include a local LCD style annunciator. All panels at the facility shall be networked together in order to allow the Main FACP to monitor each building on the site.

C. Alarms/troubles at each building shall activate the local notification devices (or report troubles) at the respective building panel only and report the alarms/troubles to the Main FACP, but shall not activate other building notification devices.

1.02 SCOPE:

A. This specification outlines the requirements for a microprocessor based, addressable (intelligent) automatic fire detection and alarm system. The system and components shall be supplied by one manufacturer of established reputation and experience who shall have produced similar apparatus for a period of at least five (5) years and who shall be able to refer to similar installations in public buildings rendering satisfactory service.

B. The work described in this specification consists of all labor, materials, equipment and services necessary and required to complete and test the automatic fire detection and alarm system. Any material not specifically mentioned in this specification or not shown on drawings but required for proper performance and operation shall be furnished, installed, and connected complete.

C. The work shall include all required programming to allow network operation between each control panel, for central monitoring from the Main FACP.

1.03 REQUIREMENTS:

A. This installation shall be made in accordance with the drawings, specification and the following:

1. National Electrical Code Article 760
2. NFPA Standard 72
3. Local Codes and Authorities Having Jurisdiction
4. ADA requirements and regulations.

1.04 RELATED WORK:

A. Division 26: Basic materials and methods

B. Division 21: Fire protection systems

C. Division 23: HVAC systems

D. Division 21: Fire Smoke Dampers

1.05 FIRE DETECTION SYSTEM DESCRIPTION:

A. The system shall be a networkable, supervised, non-coded, 24 volt DC, power limited system and shall be capable of having all addressable initiation devices on the network in alarm at one time. Notification device circuits shall be wired Class B. Initiation device circuits shall be wired Class A. A single ground or open on any initiating device circuit or notification appliance circuit shall not cause system malfunction, loss of operating power, or the ability to report an alarm.

B. Provide initiation, notification and other devices as per specifications and indicated on drawings.

C. Indicate alarms, supervisory, and trouble signals on the main fire alarm control panel and annunciator at each building and at the main fire alarm control panel.

D. Initiate signals to control (shut-off) HVAC system units and FSD's as per drawings and as required by code.

E. Transmit alarm signals to off-site reporting agency via a digital communicator at each building panel, with specific building address ID.

F. For buildings with elevators:
   1. Each elevator machine shall be provided with a smoke detector to facilitate elevator recall as outlined below.
   2. Each elevator machine room and the top of each elevator shaft shall be provided with a heat detector mounted within 2 feet of any sprinkler head (when sprinklers are provided), to facilitate elevator power shunt trip as outlined below.
   3. Each elevator landing shall be provided with a smoke detector to facilitate elevator recall as outlined below.
   4. Control modules shall be provided at the elevator machine room to initiate recall and alternate recall functions as outlined below.
   5. Control modules shall be provided at any elevator smoke doors to initiate smoke door release upon local landing smoke detector alarm.
   6. Activation of any machine room, elevator shaft, or elevator landing smoke detector shall initiate elevator recall functions to the main floor, via a signal to the associated control module. Exception; the main floor elevator landing or machine room detector shall initiate elevator recall to the alternate floor via a signal to the associated control module.

7. Activation of any machine room or shaft heat detector shall initiate elevator main power shunt trip for disconnection of power prior to application of any water onto or into the elevator equipment or shaft, from the sprinkler system.

G. The fire alarm system shall function as follows when any smoke or duct detector, waterflow switch, manual station or other initiating device operates:
   1. Operate required audible/visual and visual devices as shown on the Drawings.
   2. Automatically notify off-site reporting agency.
   3. Indicate at the control panel alphanumeric display the number and location of the alarmed device.
   4. Light an indicating lamp on the smoke detector initiating the alarm.
   5. Light an indicating lamp on the remote annunciator indicating the location alarmed as well as the type of device alarmed (area smoke detector, duct detector, manual pull station, waterflow switch, ansul system panel, valve supervisory switch, etc.).

H. Provide additional system features and capacities as indicated in Part 2 of this Section of the Specifications.

1.06 GUARANTY:

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

1.07 SUBMITTALS:

A. Submit fire alarm shop drawings and product data sheets in accordance with Division 01 and Section 26 05 00.

B. This Contractor shall submit the completed Fire Alarm Shop Drawings, with associated equipment cut sheets and CSFM listings, to the local Fire Department and submit for a seperate Fire Alarm System Permit as required by the local authority. Final Fire Alarm System approval (by the AHJ) and Permit shall be based on the shop drawings submitted and completed by the Contractor. The design drawings are for overall system requirements and layout only.

C. Shop Drawings shall indicate the following: building floor plan, location and type of devices, conduit and wire quantities, power requirements, complete wiring point-to-point diagrams, details, and locations of fire alarm and remote annunciator panels. Submittal shall include a system 1-line riser diagram with all devices and equipment and interconnections shown.

D. Submit manufacturer's installation instructions including back-box requirements for each piece of equipment.

E. Submit manufacturer's operating instructions and maintenance data.

F. Submit voltage drop and battery calculations.

1.08 APPLICABLE PUBLICATIONS:

The publications listed below form a part of this specification.

A. National Fire Protection Association (NFPA) - USA:

No. 70- National Electrical Code (NEC)

No. 72 - National Fire Alarm Code

No. 101Life Safety Code

B. Underwriters Laboratories Inc. (UL) - USA:

No. 268Smoke Detectors for Fire Protective Signaling Systems

No. 864Control Units for Fire Protective Signaling Systems

No. 268ASmoke Detectors for Duct Applications

No. 521Heat Detectors for Fire Protective Signaling Systems

No. 464Audible Signaling Appliances

No. 1971Visual Signaling Appliances

No. 38Manually Actuated Signaling Boxes

No. 346Waterflow Indicators for Fire Protective Signaling Systems

C. Local and State Building Codes.

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.09 APPROVALS:

A. The control panel and all peripherals shall have proper listing and/or approval from Underwriters Laboratory (UL) and be California State Fire Marshall listed and approved.

PRODUCTS

2.01 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model.

B. The system shall be UL 864 (9th Edition) listed.

C. Acceptable System Manufacturers: Notifier, EST, Simplex, Siemens, or equal.

D. The system design is based on Notifier products and has been approved by DSA as such. Deviations from the approved design (for manufacturer or device layouts) may be allowed with approval by the engineer, however, it shall be the Contractors responsibility to redesign and resubmit the plans to DSA for re-approval.

E. All equipment and components shall be installed in strict compliance with manufacturers' recommendations.

F. All Equipment shall be attached to and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.02 **CONDUIT, BOXES, AND WIRE:**

A. Plenum rated fire alarm cabling is acceptable when installed in compliance with NFPA and NEC requirements and properly listed for such use. Any fire alarm cabling installed outside of raceways or boxes shall be installed in a protected location to avoid possible physical damage.

B. All conduit and wire shall comply with section 26 27 00 of these specifications.

C. Conduit:
   1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
   2. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
   3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
   4. Conduit shall be 3/4 inch minimum.

D. Wire:
   1. All fire alarm system wiring shall be new and installed in conduit or shall be plenum and fire alarm system rated, installed to be protected from physical damage.
   2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760). Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG for initiating device circuits and signaling line circuits, and 12 AWG for Notification device circuits.
   3. All field wiring shall be completely supervised, Class A for initiation loops, and Class B for notification loops, with end-of-line devices located as shown on the riser diagram.
   4. All Class A loops shall include a return cable to the fire alarm panel terminals, per Class A and manufacturer's wiring requirements.

E. Terminal Boxes, Junction Boxes and Cabinets:
   1. All boxes and cabinets shall be UL listed for their use and purpose.

F. Each Fire Alarm Control Panel and expander panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the power panel as FIRE ALARM and include a breaker handle lock for the dedicated breaker. Fire alarm control panel primary power wiring shall be #12 AWG. The control panel cabinet shall be properly grounded.

2.03 CONTROL PANEL:

A. The control panel shall be microprocessor based and totally power limited. The panel shall be capable of supporting Class A (Style 6) or Class B (Style 4)Network Communications lines, and Class A (Style Z) or Class B (Style Y) Notification Circuits.

The panel shall have the following features; Totally Field Programmable, Password Access Protection, Built in Panel Diagnostics, Alarm and Trouble Resound, Alarm Event Buffer, Trouble Status Buffer, Point Identification Display, 24 hour Trouble resound, One Man Walk Test, Alarm Verification, and Positive Alarm Sequence. The panel shall have the following relays with a form C configuration; Alarm, Trouble, Supervisory, and Default Alarm Mode (to allow alarm reporting during microprocessor failure).

B. The control panel shall be designed to monitor and process a minimum of 198 addressable inputs (smoke detectors, manual stations water flow devices, etc.), and up to 198 addressable monitor or control modules. The Network Communication Lines shall support various annunciation devices (i.e. LED Annunciators, Alphanumeric Displays, Printers) in addition to the addressable inputs and outputs described above. The system architecture shall allow for T-tapping of the Network Communications Lines. The use of a Zone Monitor module on the Communications Line shall further enhance the system with a master/slave concept, of allowing a group of conventional detection devices (standard smoke detectors manual stations, waterflow and tamper switches) to be interfaced into the system as an address point. The system shall include individual power supply expander panels as required to support the notification loops. Each notification circuit shall be independently field programmable by the use of addressable control modules rated for the required current.

C. The control panel shall contain an Alphanumeric Display interface which contains a microprocessor with a non-volatile memory to store field programmable alarm and trouble messages. The Alphanumeric Display shall consist of two 40 character lines for alarm, supervisory and trouble identification, and in quiescent mode, indicates system status.

D. The control panel shall have history reporting, with the history stored in either the alphanumeric or printer modules. The history shall be at least 1,000 events. These events can be alarm, verification, supervisory, trouble, acknowledge, system reset, walk test, and the use of any panel keypad keys and access to any panel modes such as Program or Test.

E. The control panel shall have self diagnosis. Once the program is stored in memory and upon system initiating, if there is a discrepancy between the number of devices entered into the program and the actual number of devices connected to the system, the panel shall annunciate a trouble for the devices in question.

F. Power Supply
   1. The Power Supply for the Fire Alarm Control Panel may be integral or external to the Fire Alarm Control Panel, and shall provide all control panel and peripheral device power needs. Additional power required to operate all alarm devices (above and beyond the capacity of the main panel supply) shall be provided with power expander panel(s), connected to the alarm output of the main control panel. Provide all required interface modules and relays for proper notification circuit operation as per manufacturers instructions. Expander panel shall be as manufactured by the chosen Fire Alarm System manufacturer (qty. as required for full alarm operation).
   2. Input power shall be provided at 120 VAC, 60 HZ. The power supply shall provide an integral battery charger for use with a minimum of 12 AH batteries.

3. It shall provide a minimum of 6.0 amperes of regulated 24 VDC power for Audio-Visual alarm notification devices, 200 mA of 4-wire smoke detector power, and 200 mA of Non-Resettable power.
4. The power supply shall be designed to meet UL and NFPA requirements for power-limited operation on all initiating and notification circuits.
5. Positive-temperature-coefficient thermistors, circuit breakers, fuses, or other over-current protection shall be provided on all power outputs.

G. Mechanical Design: The control panel shall be housed in a cabinet designed for mounting directly to a wall or vertical surface. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top. No conduit penetrations shall be utilized on the back or bottom of the panel. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. The cabinet shall be approximately 5 inches deep and 14.5 inches wide. Height shall be approximately 16 inches.

2.04 INITIATION DEVICES:

A. The manufacturer of choice, Addressable Photoelectric Smoke detectors, (Intelligent) shall be provided as indicated on the drawings, with features and characteristics as follows:
   1. The detector shall be self compensating for ambient temperature and humidity.
   2. The detector shall be addressed, tested and programmed prior to installation using a UL listed programmer/tester. The detector readout shall yield a discrete electrical value for status tracking and logging for determining maintenance and cleaning requirements.
   3. The detector shall be suitable for two wire operation and two way communication on the intelligent analog signalling circuits.
   4. The detector shall display a flashing red LED when in the alarm state when the system is operating from normal or standby power.
   5. The detectors furnished shall be listed for use in environments as covered by Factory Mutual, UL and shall be installed according to the requirements of NFPA 72 for open area coverage.
   6. Detectors for magnetic door hold open functions shall be provided with an auxiliary relay base for auxiliary function wiring connections.
      a. Door holder power shall be routed via the relay base on smoke detectors denoted with an "R" to release the associated doors upon alarm.

B. Heat detectors shall be provided as indicated on drawings. Heat detector shall be of the rate compensation type, 135 degree.

C. Duct Detectors:
   1. Duct detectors for air-handling units, complete with all required sampling tubes and housings, shall be provided and connected complete by this contractor, installed by the mechanical contractor. Coordinate with the mechanical contractor.
   2. Duct Detectors shall be connected to the air handler starter unit, in order to facilitate unit shut-down upon alarm (via an auxiliary relay in the duct detector). Coordinate exact control wiring with mechanical contractor. Provide and install all required wiring and conduit for starter/duct detector interface.

3. Provide and install power connection to each duct detector as required. Coordinate with mechanical contractor.
4. Provide Nema 3R exterior rated housings for all exterior duct detectors.

D. Manual Stations, (Intelligent) shall be single action and semi-flush or surface mounted as indicated on the drawings.
   1. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring.
   2. The manual stations shall be addressable and identifiable by the master fire alarm control panel when they are resident on the analog loop. Address programming shall be accomplished electronically and reside within the station in non volatile memory.

E. A monitor module Interface device shall be provided for required interface points such as water flow devices and tamper switches, or any contact type devices as indicated on drawings. This Interface device shall have one or two Class B (Style 4) circuits as required.

F. Provide a 120VAC circuit connection to each sprinkler system water flow bell (provided by Mechanical Div.). Wire power via the local water flow switch aux. Contact to activate the bell upon water flow activation.

2.05 REMOTE ANNUNCIATOR:

A. A remote annunciator shall be provided as shown on the plans. The annunciator shall be wall mounted in a multi-gang box or as required. It shall provide a 80 character display to indicate the zone(s) in alarm and LED's for system trouble and supervisiory conditions.

B. The annunciator shall include a lockable and latched door with glass front to allow viewing of all indicators.

C. The annunciator shall inlude a local sounder with reset and alarm acknowledge, including key lock-out.

2.06 BATTERIES

A. Batteries shall be 12 volt, sealed Gell-Cell type, with combined Amp-Hour ratings as required by code.

B. Battery shall have a minimum sufficient capacity to power the fire alarm system for not less than twenty-four hours in standby mode, plus 5 minutes of full system alarm upon a normal AC power failure.

C. The batteries are to be completely maintenance free, no liquids required. Fluid level checks, refilling, spills and leakage shall not be required.

2.07 CONTROL DEVICES:

A. Control modules shall be provided as indicated on the drawings for fire alarm output functions. These devices shall be connected to the Network Communications Lines, and be field programmable for one of the following options; Remote Relay (form C

1amp 24vdc, 200ma 120vac) with supervised relay operation, Remote Supervised Indicating Appliance Circuit (fused at 1 amp). There shall be an LED on the device that will flash to indicate the unit is being monitored and a steady LED to indicate the unit has been activated. Secondary relays with control power connections shall be provided as required where contact ratings (voltage & amps) so dictate.

2.08 NOTIFICATION DEVICES:

A. Horn/Strobe combinations shall be provided as indicated on drawings. The horn / strobe combination shall be Wheelock or equal, ADA and UL 1971 compliant (candela values as required) - White finish.

B. Strobe Lights shall be provided as indicated on drawings. The strobe lights shall be wall mounted at +80" AFF or 6" below the ceiling level, whichever is lower, Wheelock or equal, ADA and UL 1971 compliant (candela values as required) - White finish.

C. Refer to Part 3 below for required synchronization of strobes when located in the same field of view.

2.09 FIRE / SMOKE DAMPERS:

A. Fire / Smoke dampers (FSD's) are provided and installed by Division 23. This contractor shall provide and install a 120V power connection to each damper, wired to keep the damper in the open position under normal conditions.

B. An integral duct smoke detector will be provided by Division 21. This contractor shall provide and install an addressable monitor module, connected to the alarm contacts on the duct detector, to monitor the condition of the detector and annunciate an alarm condition to the main control panel upon detection of smoke.

C. This contractor shall wire the 120V control power for the FSD's via an auxiliary alarm contact in the detector base, to automatically close the damper upon smoke detection. Coordinate all provisions with the mechanical contractor and engineer.

D. All FSD provisions shall comply with the applicable sections and requirements of the CBC and the local AHJ.

E. Every effort has been made to indicate all required damper locations at rated partitions in coordination with Division 21 work. This contractor shall coordinate with the sub-mechanical contractor to identify all required locations for FSD's and provide connections to all units as required by code. The architectural drawings indicate by symbol, all such rated partitions. No extra cost shall be approved for additional required connections not shown on the drawings.

EXECUTION

3.01 INSTALLATION:

A. Installation shall be performed by current factory-authorized contractor of the specified system.

B. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

C. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

D. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

E. Provide identification labeling on all devices to identify loop and device number/address. Labeling shall consist of min. 3/8" black lettering on white background P-Touch style adhesive labels with machine printing, Helvetica font or similar.

F. At the final inspection a factory trained representative of the manufacturer of the major equipment shall perform the tests in Section 3.2 TESTS.

G. WIRING:
   1. All circuits shall be in conduit, minimum 3/4".
   2. Addressable loops circuits shall be two (2) conductor twisted/shielded or wiring approved by the manufacturer. Notification circuits shall be 12 AWG minimum for strobes, but not to exceed manufacturers wire capacity for modules. Control power circuits shall be 14 AWG minimum or as required.
   3. When (3) or more visual notification devices are located within the same field of view and are less than 55 feet apart (within the field of view), all devices within that field of view shall be synchronized to provide the same flash rate and frequency. Provide all required sync modules and compatible strobe devices to provide a synchronized output.

3.02 TESTING:

A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Each building shall be separately tested as completed and the entire networked system tested just prior to project completion. Include contractor pre-test for each building prior to the final AHJ testing to insure a suitable final test result.
   1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
   2. Close each sprinkler system flow valve and verify proper supervisory alarm at the respective FACP and/or annunciator.
   3. Verify activation of all flow switches.
   4. Open initiating device circuits and verify that the trouble signal actuates at the respective FACP and/or annunciator.
   5. Open and short all notification appliance circuits and verify that trouble signals actuate at the respective FACP and/or annunciator.

6. Ground circuits and verify response of trouble signals at the respective FACP and/or annunciator.
7. Check presence and audibility of tone at all alarm notification devices.
8. Check installation, supervision, and operation.
9. Verify that each initiating device alarm is properly received and processed by the respective FACP and annunciator (Walk Test).
10. Conduct tests from each FACP to verify trouble indications for common mode failures, such as alternating current power failure.

B. Test reports shall include, but not be limited to:
   1. A complete list of equipment installed indicating proper operations as listed above.

3.03 FINAL INSPECTION:

A. Final acceptance will require the contractor to deliver to the Owner the following;
   1. Three (3) copies of the operating instructions and system maintenance manuals.
   2. Three (3) set of record drawings.
   3. Three (3) copies of the final test reports.
   4. Three (3) copies indicating the name and phone number of person to contact in the event of equipment failure, and date when system warranty will be terminate.
   5. Three (3) sets of data sheets for each piece of equipment supplied.

B. The fire alarm system subcontractor or manufacturer shall offer for the owners consideration at the time of system submittal a priced inspection, maintenance, testing and repair contract in full compliance with the requirements of NFPA 72.
   1. The services offered under this contract shall be performed at no charge during the first year after system acceptance and the owner shall have the option of renewing for single or multiple years, up to five years, at the price quoted in bid.
   2. The contractor performing the contract services shall be qualified and listed to maintain ongoing certification of the completed system to the UL for specific installed system listing.

3.04 WARRANTY

A. The fire detection system shall be warranted for a period of one year from date of acceptance. The warranty shall cover parts, labor, and travel to and from the site.

3.05 INSTRUCTION:

A. Provide complete instruction manuals and training to the building personnel. "Hands-on" demonstrations of the operation of all system components and the entire system shall be provided.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Clearing vegetation, debris, trash and other materials within limits indicated.

B. Grubbing of vegetation within limits indicated.

1.2 RELATED DOCUMENTS

A. Caltrans Standard Specifications.
Section 16, Clearing and Grubbing.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and clearly flag vegetation to remain or to be relocated.

3.2 RESTORATION

A. Repair or replace vegetation indicated to remain that is damaged by construction operations, as directed by the Owner.

B. Employ a qualified arborist, licensed in jurisdiction where the Project is located, to submit details of proposed repairs and to repair damage to shrubs.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.

B. Remove trash, debris, logs, concrete, masonry and other waste materials.

C. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

D. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18-inches below subgrade.

E. Use only hand methods for grubbing within drip line of remaining trees.

END OF SECTION

PART 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.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

PART 1

PART 2

3.1 PREPARATION

A. 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

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, and other 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

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Excavation and/or embankment from existing ground to subgrade, including soil sterilant, for roadways, driveways, parking areas, walks, paths, or trails and any other site improvements called for on the Plans.

1.2 SECTION EXCLUDES

A. Earthwork related to underground utility installation, see Section 31 23 33 – Trenching and Backfilling.

1.3 RELATED SECTIONS

A. Section 31 11 00 – Clearing and Grubbing

B. Section 31 23 33 – Trenching and Backfilling

C. Section 31 31 19 – Vegetation Control

D. Section 33 46 00 – 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.

D. Structural Backfill: Soil materials approved by the Geotechnical Consultant and used to fill excavations resulting from removal of existing below grade facilities, including trees. See Section 31 23 33 – Trenching and Backfilling.

E. Structural Fill: Soil materials approved by the Geotechnical Consultant and used to raise existing grades.

F. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material ¾-cubic yards or more in volume that 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.

C. Shoring Drawings: All shoring and re-shoring drawings are to be prepared by, signed, and sealed by a Professional Engineer registered in the State of California.

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 24-hours prior to commencement of earthwork and at least 48 hours prior to testing.

E. The Geotechnical Consultant will perform observations and tests required to enable him to form an opinion of the acceptability of the Project earthwork. Correct earthwork that, in the opinion of the Geotechnical Consultant, does not meet the requirements of these Technical Specifications and the Geotechnical Report.

F. Upon completion of the construction work, certify that all compacted fills and foundations are in place at the correct locations, and have been constructed in accordance with sound construction practice. In addition, certify that the materials used are of the types, quality and quantity required by these Technical Specifications 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: +0.05 feet.

2. Landscape areas: ±0.10 feet.

3. Cut or fill slopes: ±0.50 feet.

1.8 PROJECT CONDITIONS

A. Promptly notify the Owner of surface or subsurface conditions differing from those disclosed in the Geotechnical Report. First notify the Owner verbally to permit verification

and extent of condition and then in writing. No claim for conditions differing from those anticipated in the Contract Documents and disclosed in the Geotechnical Report will be allowed unless the Contractor has notified the Owner in writing of differing conditions prior to the Contractor starting work on affected items.

B. Protect open excavations, trenches, and the like with fences, covers and railings to maintain safe pedestrian and vehicular traffic passage.

C. Prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

D. Temporarily stockpile fill material in an orderly and safe manner and in a location approved by the Owner.

E. Provide dust and noise control in conformance with Division 1 General Requirements.

F. Environmental Requirements: When unfavorable weather conditions necessitate interrupting earthwork operation, areas shall be prepared by compaction of surface and grading to avoid collection of water. Provide adequate temporary drainage to prevent erosion. After interruption, compaction specified in last layer shall be re-established before resuming work.

PART 2- PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from on-site excavations.

B. Obtain approval of on-site soil materials and borrow materials to be used for structural fill or structural backfill from the Geotechnical Consultant.

C. On-Site Structural Fill and Structural Backfill: Soil or soil-rock mixture from on site excavations, free from organic matter or other deleterious substances. On-site structural fill and backfill shall not contain rocks or rock fragments over 3 inches in greatest dimension, shall have a liquid limit of less than 45, a plasticity index of less than 25, 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 6 inches below final subgrade elevations and 5-feet beyond edge of pavement unless specified otherwise by the Geotechnical Consultant. Uniformly moisture condition to obtain optimum moisture contents. Break clods and condition surface by harrowing or dry rolling. Remove boulders, hard ribs and solid rock. Prepare earth uniform for full depth and width of subgrade.

D. Protect utilities from damage during compaction of subgrades and until placement of final pavements or other surface facilities.

E. Obtain the Geotechnical Consultant's approval of subgrades prior to placing pavement.

3.9 PLACEMENT OF STRUCTURAL FILL

A. Obtain the Geotechnical Consultant's approval of surface to receive structural fill prior to placement of structural fill material.

B. Place structural fill on prepared subgrade.

C. Spread structural fill material in uniform lifts not more than 8-inches in un-compacted thickness and compact.

D. Place structural fill material to suitable elevations above grade to provide for anticipated settlement and shrinkage.

E. Overbuild fill slopes, as required by the Geotechnical Consultant, to obtain required compaction. Remove excess material to lines and grades indicated.

F. Do not drop fill on structures. Do not backfill around, against or upon concrete or masonry structures until structure has attained sufficient strength to withstand loads imposed and the horizontal structural system had been installed.

3.10 KEYWAYS AND BENCHES

A. Provide keyways as indicated for fill slopes steeper than 6 horizontal to 1 vertical. Extend keyway 5-feet minimum into competent, undisturbed soil or 3-feet minimum into competent, undisturbed rock as directed by the Geotechnical Consultant.

B. Place subsurface drains in bottom of keyway in conformance with Section 33 46 00 – Subdrainage.

C. Bench subgrade as indicated above toe of fill.

D. Place subsurface drains at benches every 20 vertical feet or as directed by the Geotechnical Consultant.

3.11 COMPACTION AND TESTING

A. Do not compact by ponding, flooding or jetting.

B. Compact soils at optimum water content. Aerate material if it is too wet. Add water to material if it is too dry. Thoroughly mix lifts before compaction to ensure uniform moisture distribution.

C. Perform compaction using rollers, pneumatic or vibratory compactors or other equipment and mechanical methods approved by the Geotechnical Consultant.

D. Compaction requirements:

1. Compact structural fills less than 5-feet thick to 90 percent compaction.

2. Compact structural fill 5-feet thick or greater to 95 percent compaction.

3. Compact the upper 6 inches of subgrade soils beneath pavements, curbs and gutters to 88 to 93 percent compaction. Extend compaction 5-feet beyond pavement edges unless specified otherwise by the Geotechnical Consultant.

4. Compact the upper 6-inches of subgrade soils under walks, structures and areas to receive structural fill to 88 to 93 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

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 31 23 00 – Excavation and Fill

B. Section 33 10 00 – Water Utilities

C. Section 33 30 00 – Sanitary Sewerage

D. Section 33 46 00 – Subdrainage

E. Section 33 40 00 – 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 ½ the outside diameter measured from the top or bottom of the pipe.

J. Subsequent Backfill: Material from 12-inches above top of pipe to subgrade of surface material or subgrade of surface facility or to finish grade.

K. Trench Excavation: Removal of material encountered above subgrade elevations and within horizontal trench dimensions.

1. Authorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions as shown on plans or authorized by the Geotechnical Consultant.

2. Unauthorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions without authorization by the

Geotechnical Consultant. Unauthorized excavation shall be without additional compensation.

L. Utility Structures:

1. Storm drainage manholes, catch basins, drop inlets, curb inlets, vaults, etc.

2. Sanitary sewer manholes, vaults, etc.

3. Water vaults, etc.

1.6 SUBMITTALS

A. Follow submittal procedures outlined in 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, except that the upper 36-inches in areas subject to vehicular traffic shall be compacted to at least 95% relative compaction, unless specified otherwise on the Plans or by the Geotechnical Consultant. Compact by pneumatic tampers or other mechanical means approved by the Geotechnical Consultant. Jetting or ponding of subsequent backfill material will not be permitted.

D. Do not use compaction equipment or methods that produce horizontal or vertical earth pressures that may cause excessive pipe displacement or damage the pipe.

E. Utility backfill shall be inspected and tested by the Geotechnical Consultant during placement. Cooperate with the Geotechnical Consultant and provide working space for such tests in operations. Backfill not compacted in accordance with these specifications shall be re-compacted or removed as necessary and replaced to meet the specified requirements, to the satisfaction of the Geotechnical Consultant and the Owner prior to proceeding with the Project.

3.7 CLEANUP

A. Upon completion of utility earthwork all lines, manholes catch basins, inlets, water meter boxes and other structures shall be thoroughly cleaned of dirt, rubbish, debris and obstructions of any kind to the satisfaction of the Owner.

B. See Section 01 74 00 – Cleaning and Waste Management for further cleanup requirements.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. This Section pertains to the provisions for the control of erosion in the construction area and in stockpile areas including seeding, hydro-mulching, sediment barriers, fiber rolls, and temporary gravel construction entrance/exit.

B. Contractor is responsible for meeting all local, state and federal regulations regarding erosion control including the applicable provisions of the National Pollution Discharge Elimination System (NPDES) regulations from the Federal Clean Water Act.

1.2 RELATED DOCUMENTS

A. Provisions established in General and Supplementary Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

B. Geotechnical study performed by Cornerstone Earth Group dated May 28, 2014.

C. Storm Water Pollution Prevention Plan for Colma Town Hall Renovation and Addition.

PART 2 – PRODUCTS

2.1 SEDIMENT BARRIERS AND TRAPS

A. As indicated on the drawings.

2.2 FIBER ROLLS

A. As indicated on the drawings.

2.3 TEMPORARY CONSTRUCTION ENTRANCE

A. As indicated on the drawings.

PART 3 – EXECUTION

3.1 GENERAL

A. Contractor shall keep disturbed areas to a minimum required to adequately perform the work. At all times the Contractor shall maintain the site in such a manner that minimizes erosion of the site. The execution of work under this section shall be in conformance with the NPDES rulings and the site Storm Water Pollution Prevention Plan.

3.2 FILL AND CUT SLOPES

A. Fill slopes in all cases shall be no steeper than those approved by the Geotechnical Engineer.

B. When cut slopes exceed 2:1 for depths over 3 feet, proper bracing and shoring per OSHA requirements shall be used and maintained.

C. For temporary slopes, cut or fill, between 1:1 and 10:1, erosion protection shall be provided by other method as approved by the Geotechnical Engineer.

D. Fill exposed aggregate base from demolition with class II aggregate base as needed to maintain positive drainage from existing site infrastructure.

3.3 EROSION CONTROL BARRIERS

A. Erosion control barriers shall be provided at intervals along swales and ditches as shown on the drawings and as necessary to meet the requirements of the Storm Water Pollution Prevention Plan.

B. The barriers shall be fiber rolls as shown the plans or other approved barrier material. Place barriers as shown on the drawings and details and as needed.

C. Barriers shall be maintained in good working condition and replaced when damaged.

D. Erosion control mats shall be overlaid on top of exposed aggregate base after demolition of asphalt surface.

END OF SECTION

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 31 23 00 – Excavation and Fill.

1.3 RELATED DOCUMENTS

A. CAL/OSHA, Title 8.

1.4 SUBMITTALS

A. Follow submittal procedures outlined in Section 01 33 00 – 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, concreter 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

32 02 70 CRUSHED ROCK

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Perform all tree removals and site clearing as shown on documents and directed in field required to make the site ready for future improvements:

1. Remove and recycle existing trees as shown on plan and directed in the field.
2. Dispose of debris resulting from demolition off-site.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.3 SUMMARY

A. Provide all labor and material necessary for the installation of crushed rock pavements as shown on the drawings.

1.4 SUBMITTALS

A. Products:

1. A half (0.5) pound bag of decomposed granite.

B. Procedure:

1. Submit a half (0.5) pound sack of decomposed granite to the Architect ten (10) work days after Notice to Proceed and prior to performing any work.

1.5 QUALITY ASSURANCE

A. Codes and standards:

1. Perform and provide the work of Crushed Rock Pavement in compliance with all applicable local, state and federal codes, laws and regulations.

B. Substitution of materials:

1. Substitution of materials will not be permitted unless authorized in writing by the Architect. Suggested substitutions must be shown to be equal to the specified material. A written proposal will be considered for the use of the suggested material which includes a corresponding adjustment in contract price. The proposal will be submitted to the Architect 35 work days after Notice to Proceed.

PART 2 - MATERIALS

2.1 CRUSHED ROCK

A. Crushed rock is also called Decomposed Granite (D.G.). Acceptable sources of crushed rock follow. An alternative and equal source may be used if sample material and written data are submitted and approved by the Architect.

1. California Gold Path Fines by Felton Quarry, 491 Fall Creek Drive, Felton, CA. 95018, (408) 335-3445. Color: Tan or Buff.

Sieve Size	Percent Passing
#4	95-100
#30	30-50
#200	5-15
Sand equivalent	38 minimum

2. 1/4" x dust Gold Track Fines by Pilarcitos Quarry, Pilarcitos Creek Road at Highway 92, Half Moon Bay, CA, (415) 726-5286. Color: Buff.

Sieve Size	Percent Passing
#4	95-100
#30	30-50
#200	5-15
Sand equivalent	38 minimum

2.2 WATER

A. Clean and potable, free of alkali, organic matter and other materials. Provided by the Contractor.

PART 3 - EXECUTION

3.1 DELIVERY AND STORAGE

A. Protect adjacent areas and improvements during delivery and storage.

B. Protect all materials from damage caused by moisture, erosion and theft.

C. Deliver materials in original containers with labels intact and exposed for inspection.

3.2 PLACING CRUSHED ROCK

A. Place crushed rock over compacted sub-grade in areas where shown on the drawings.

B. Final thickness of compacted work shall be as shown on the drawings with a maximum variable tolerance of 1/2 (0.5) inch. Make measurements by means of test holes taken at random in the finished surface as directed by the Architect. Repair test holes after inspection.

3.3 CLEAN-UP

A. Leave crushed rock pavements smooth and free of extraneous material

B. Leave the work site clean and free of debris resulting from the work.

END OF SECTION

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 02620.

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 02300, Earthwork.

B. Section 02310, Utility Trenching and Backfill

C. Section 02630, Storm Drainage System.

D. Section 02620, Subdrainage.

1.4 RELATED DOCUMENTS

A. Geotechnical Report: See Section 02000

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 permability.
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. [Check the following against definitions in the Geotechnical Report. Revise definitions so each agrees with the Geotechnical Report. If any of the following are retained, but are not covered in the Geotechnical Report, be sure the Geotechnical Consultant agrees with the definition.]

B. ASTM: American Society for Testing and Materials.

C. Bedding: Material from bottom of trench to bottom of pipe.

D. C:N Ratio: Carbon to Nitrogen Ratio.

E. Initial Backfill: Material from bottom of pipe to 12-inches above top of pipe.

F. USCS: United States Composting Council.

G. STA: Seal of Testing Assurance.

H. TMECC: Testing Methods for the Examination of Compost and Composting.

I. Springline of Pipe: Imaginary line on surface of pipe at a vertical distance of ½ the outside diameter measured from the top or bottom of the pipe.

J. Subsequent Backfill: Material from 12-inches above top of pipe to subgrade of surface material or subgrade of surface facility or to finish grade.

K. Trench Excavation: Removal of material encountered above subgrade elevations and within horizontal trench dimensions.

1. Authorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions as shown on plans or authorized by the Geotechnical Consultant.

2. Unauthorized Trench Over-Excavation: Excavation below trench subgrade elevations or beyond indicated horizontal trench dimensions without authorization by the Geotechnical Consultant. Unauthorized excavation shall be without additional compensation.

L. Utility Structures:

1. Storm drainage manholes, catch basins, drop inlets, curb inlets, cleanouts, vaults, etc.

1.6 SUBMITTALS

A. Follow submittal procedure outlined in Section 02000.

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. [Include the following paragraph only if Owner will not have a geotechnical consultant on-site during construction.]

E. 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 Section 02000, Supplemental General Requirements for Civil Improvements.

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 120o 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 O_2 / unit TS / hr
   b. Specific oxy. Test < 1.5 O_2 / 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. NH_4- : NO_3-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**
½”	**90**	**100**
¼”	**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 Section 02000 for further cleanup requirements.

END OF SECTION

PART 1- GENERAL

1.1 SECTION INCLUDES

A. Materials for portland cement concrete.

B. Aggregate and aggregate grading for portland cement concrete.

C. Water for portland cement concrete.

D. Admixtures for portland cement concrete.

E. Proportioning for portland cement concrete.

F. Mixing and transporting portland cement concrete.

G. Formwork for cast in place portland cement concrete.

H. Embedded materials for portland cement concrete.

I. Steel reinforcement for portland cement concrete.

J. Placing and finishing portland cement concrete.

K. Curing portland cement concrete.

L. Protecting portland cement concrete.

1.2 RELATED SECTIONS

A. Section 31 23 00, Excavation and Fill

B. Section 31 31 19, Vegetation Control

C. Section 32 13 00, Rigid Paving

D. Section 32 16 13, Concrete Curbs and Gutters

E. Section 32 17 23, Pavement Markings

F. Section 33 05 13, Manhole Grade Adjustment

G. Section 33 05 16, 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. 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 alkalies, 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 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. Color Conditioned Decorative Portland Cement Concrete: LITHOCHROME colorwax as manufactured by the L. M. Scofield Company or approved equal.

2.8 FORMS

A. Conform to the requirements of Section 51-1.05 of the Caltrans Standard Specifications.

2.9 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.

2.10 PORTLAND CEMENT CONCRETE VEHICULAR PAVEMENT

A. General: See Section 32 13 00 – Rigid Paving.

PART 3- EXECUTION

3.1 STRUCTURAL EXCAVATION

A. Structural excavation may be either by hand, or by machine and shall be neat to the line and dimension shown or called for on the plans. Excavation shall be sufficient width to provide adequate space for working therein, and comply with CAL-OSHA requirements.

B. Where an excavation has been constructed below the design grade, refill the excavation to the bottom of the excavation grade with approved material and compact in place to 95% of the maximum dry density.

C. Remove surplus excavation material remaining upon completion of the work from the job site, or condition it to optimum moisture content and compact it as fill or backfill on the site, if the material is approved by the Geotechnical Consultant.

3.2 SOIL STERILANT

A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.

3.3 BRACING AND SHORING

A. Conform to California and Federal OSHA requirements.

B. Place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; to prevent damage to the facility being constructed; and to prevent damage to adjacent structures or facilities. Remove all bracing and shoring upon completion of the work.

C. Be solely responsible for all bracing and shoring and, if requested by the Owner's Representative, submit details and calculations to the Owner's Representative. The Owner's Representative may forward the submittal to the Geotechnical Consultant, the Consulting Engineer and/or the California Division of Industrial Safety for their review. The Contractor's submittal shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a civil engineer or structural engineer registered in California. No excavations related to the proposed facility shall precede a response to the submittal by the Owner's Representative.

D. Be solely responsible for installing and extracting the sheathing in a manner which will not disturb the position or operation of the facility being constructed or adjacent utilities and facilities.

3.4 PLACING CONCRETE FORMS

A. Form concrete improvements with a smooth and true upper edge. Side of the form with a smooth finish shall be placed next to concrete. Construct forms rigid enough to withstand the pressure of the fresh concrete to be placed without any distortion.

B. Thoroughly clean all forms prior to placement and coat forms with an approved form oil in sufficient quantity to prevent adherence of concrete prior to placing concrete.

C. Carefully set forms to the alignment and grade established and conform to the required dimensions. Rigidly hold forms in place by stakes set at satisfactory intervals. Provide sufficient clamps, spreaders and braces to insure the rigidity of the forms.

D. Provide forms for back and face of curbs, lip of gutters and edge of walks, valley gutters or other surface slabs that are equal to the full depth of the concrete as shown, noted or called for on the Plans. On curves and curb returns provide composite forms made from benders or thin planks of sufficient ply to ensure rigidity of the form.

3.5 PLACING STEEL REINFORCEMENT

A. Bars shall be free of mortar, oil, dirt, excessive mill scale and scabby rust and other coatings of any character that would destroy or reduce the bond. All bending shall be

done cold, to the shapes shown on the plans. The length of lapped splices shall be as follows:

1. Reinforcing bars No. 8, or smaller, shall be lapped at least 45 bar diameters of the smaller bar joined, and reinforced bars Nos. 9, 10, and 11 shall be lapped at least 60 bar diameters of the smaller bars joined, except when otherwise shown on the plans.

2. Splice locations shall be made as indicated on the plans.

B. Accurately place reinforcement as shown on the plans and hold firmly and securely in position by wiring at intersections and splices, and by providing precast mortar blocks or ferrous metal chairs, spacers, metal hangers, supporting wires, and other approved devices of sufficient strength to resist crushing under applied loads. Provide supports and ties of such strength and density to permit walking on reinforcing without undue displacement.

C. Place reinforcing to provide the following minimum concrete cover:

1. Surfaces exposed to water: 4-inches.

2. Surfaces poured against earth: 3-inches.

3. Formed surfaces exposed to earth or weather: 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.

2. Color Conditioned Decorative Portland Cement Concrete: Apply LITHOCHROME colorwax in accordance with the manufactures instructions.

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. Provide a medium broom finish to all horizontal surfaces unless otherwise shown.

3.12 FORM REMOVAL

A. Remove forms without damage to the concrete. Remove all shores and braces below the ground surface, before backfilling.

B. Do not backfill against concrete until the concrete has developed sufficient strength to prevent damage.

C. Leave forms for cast-in-place walls in place at least 72 hours after pouring.

D. Leave edge forms in place at least 24 hours after pouring.

3.13 CONSTRUCTION

A. Form, place and finish concrete walkways, island paving, valley gutters and driveway approaches in conformance with the applicable requirements of Section 73-1.04 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 ½-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

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Aggregate base.

1.2 RELATED SECTIONS

A. Section 31 23 00 – Excavation and Fill

B. Section 32 12 00 – Flexible Paving

C. Section 32 13 00 – Rigid Paving

1.3 RELATED DOCUMENTS

A. Geotechnical Report.

B. ASTM:

1. D 3740, Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

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 ¾-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 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

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 31 31 19 – Vegetation Control

B. Section 32 11 00 – 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.

2. Asphalt Curbs: use grade PG 70-10

3. All other asphalt products: use grade PG 64-10.

4. Prime Coat: Caltrans Standard Specification Section 92, SC-70.

5. Tack Coat: Caltrans Standard Specification Section 93, SS1.

6. 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

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Furnishing, placing, spreading, compacting and shaping portland cement concrete pavement with undoweled transverse weakened plane joints, for vehicular traffic.

B. Form construction and use in placing portland cement concrete pavement.

C. Joints for portland cement concrete pavement.

D. Finishing portland cement concrete pavement.

E. Curing and protecting portland cement concrete pavement.

1.2 RELATED SECTIONS

A. Section 31 31 19 – Vegetation Control

B. Section 32 05 23 – Cement and Concrete for Exterior Improvements

1.3 RELATED DOCUMENTS

A. Geotechnical Report.

B. AASHTO Standard Specifications

1. T 53: Softening Point of Bitumen (Ring-and-Ball Apparatus).

C. ASTM Standards

1. A 615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
2. A 775: Epoxy Coated Reinforcing Steel Bars.
3. A 934: Epoxy-Coated Prefabricated Steel Reinforcing Bars.
4. C 881: Epoxy-Resin-Base Bonding Systems for Concrete.
5. D 2628: Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.
6. D 2835: Lubricant for Installation of Preformed Compression Seals in Concrete Pavements.
7. D 3405: Joint Sealants, Hot Poured, for Concrete and Asphalt Pavements.
8. D 3963: Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel.

D. Caltrans Standard Specifications:

1. Section 40, Portland Cement Concrete Pavement.

2. Section 52, Reinforcement.
3. Section 90, Portland Cement Concrete.
4. Section 95, Epoxy.

E. Caltrans Standard Plans:

1. Plan A35A: Portland Cement Concrete Pavement (Undoweled Transverse Joints).
2. Plan A35C: Portland Cement Concrete Pavement Joint and End Anchor Details.

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ASTM: American Society for Testing and Materials.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mix Concrete Plant Certification Program.

B. Installer Qualification: An experienced installer who has completed pavement work similar in material, design and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

1.6 SUBMITTALS

A. Follow submittal procedures outlined in Division 1.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results or other circumstances warrant adjustments.

C. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements.

1. Cementitious materials and aggregates.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compound.
5. Applied finish material.

6. Bonding agent of adhesive.
7. Joint filler.
8. Joint Sealant.
9. Tie Bars.
10. Epoxy.
11. Backer Rods.

PART 2 - PRODUCTS

PART 1

2.1 PORTLAND CEMENT CONCRETE

A. General: Conform to Caltrans Standard Specifications, Section 90. Use Class 2 Concrete.

2.2 TIE BARS

A. Deformed reinforcing steel bars conforming to the requirements of ASTM Designation A 615/A (615M), Grade 40 or 60 (Grade 300 or 420).

B. Epoxy-coat in conformance with the provisions in Section 52-1.02B of Caltrans Standard Specifications, except that references made to ASTM Designation D 3963/D 3963M shall be deemed to mean ASTM Designation A 934/A 934M or A 775/775M.

C. Do not bend tie bars.

2.3 EPOXY

A. Bond tie bars to existing concrete with epoxy resin conforming to Section 95-2.03, "Epoxy Resin Adhesive for Bonding New Concrete to Old Concrete," of the Caltrans Standard Specifications.

2.4 SILICONE JOINT SEALANT

A. Furnish low modulus silicone joint sealant in a one-part silicone formulation. Do not use acid cure sealants. Compound to be compatible with the surface to which it is applied and conform to the following requirements:

Specification	Test Method	Requirement
Tensile stress, 150% elongation, 7-day cure at 25°± 1°C and 45% to 55% R.H.[e]	**ASTM D 412 (Die C)**	**310 kPa max.**
Flow at 25° ± 1°C	**ASTM C 639[a]**	**Shall not flow from channel**
Extrusion Rate at 25° ± 1°C	**ASTM C 603[b]**	**75-250 g/min.**
Specific Gravity	**ASTM D 792 Method A**	**1.01 to 1.51**
Durometer Hardness, at -18°C, Shore A, cured 7 days at 25° ± 1°C	**ASTM C 661**	**10 to 25**
Ozone and Ultraviolet Resistance, after 5000 hours	**ASTM C 793**	**No chalking, cracking or bond loss**
Tack free at 25° ± 1°C and 45% to 55% R.H.[e]	**ASTM C 679**	**Less than 75 minutes**
Elongation, 7 day cure at 25° ± 1°C and 45% to 55% R.H.[e]	**ASTM D 412 (Die C)**	**500 percent min.**
Set to Touch, at 25° ± 1°C and 45% to 55% R.H.[e]	**ASTM D 1640**	**Less than 75 minutes**
Shelf Life, from date of shipment	**—**	**6 months min.**
Bond, to concrete mortar-concrete briquets, air cured 7 days at 25° ± 1°C	**AASHTO T 132[c]**	**345 kPa min.**
Movement Capability and Adhesion, 100% extension at -18°C after, air cured 7 days at 25° ± 1°C, and followed by 7 days in water at 25° ± 1°C	**ASTM C 719[d]**	**No adhesive or cohesive failure after 5 cycles**

Notes:

ASTM Designation: C 639 Modified (15 percent slope channel A).
ASTM Designation: C 603, through 3-mm opening at 345 kPa.
Mold briquets in conformance with the requirements in AASHTO Designation: T 132, sawed in half and bonded with a 1.5 mm maximum thickness of sealant and tested in conformance with the requirements in AASHTO Designation: T 132. Briquets shall be dried to constant mass at 100 ± 5° C.
Movement Capability and Adhesion: Prepare 305 mm x 25 mm x 75 mm concrete blocks in conformance with the requirements in ASTM Designation: C 719. A sawed face shall be used for bond surface. Seal 50 mm of block leaving 12.5 mm on each end of specimen unsealed. The depth of sealant shall be 9.5 mm and the width 12.5 mm.
R.H. equals relative humidity.

B. Formulate the silicon joint sealant to cure rapidly enough to prevent flow after application on grades of up to 15 percent.

C. Furnish to the Owner a Certificate of Compliance. Accompany certificate with a certified test report of the results of the required tests performed on the sealant material within the previous 12 months prior to proposed use. Provide the certificate and accompanying test report for each lot of silicone joint sealant prior to use on the project.

2.5 ASPHALT RUBBER JOINT SEALANT

A. Conform to the requirements of ASTM Designation: D 3405 as modified herein or to the following:

1. Provide a mixture of paving asphalt and ground rubber. Ground rubber to be vulcanized or a combination of vulcanized and de-vulcanized materials ground so that 100 percent will pass a 2.36-mm sieve and contain not less than 22 percent ground rubber, by mass. Modifiers may be used to facilitate blending.

2. The Ring and Ball softening point shall be 57°C minimum, when tested in conformance with the requirements in AASHTO Designation: T 53.

3. Provide asphalt rubber sealant material capable of being melted and applied to cracks and joints at temperatures below 204°C.

B. The penetration requirement of Section 4.2 of ASTM Designation: D 3405 do not apply. The required penetration at 25°C, 150g, 5s, shall not exceed 120.

C. The resilience requirement of Section 4.5 of ASTM Designation: D 3405 do not apply. The required resilience, when tested at 25°C, shall have a minimum of 50 percent recovery.

D. Accompany each lot of asphalt rubber joint sealant shipped to the job site, whether as specified herein or conforming to the requirements of ASTM Designation D 3405, as modified herein, by a Certificate of Compliance, storage and heating instructions and precautionary instructions for use.

E. Heat and place in conformance with the manufacturer's written instructions and the details shown on the plans. Provide manufacturer's instructions to the Owner. Do not place when the pavement surface temperature is below 10°C.

2.6 PREFORMED COMPRESSION JOINT SEALANT

A. Material: ASTM Designation: D 2628.

1. Number of cells: 5 or 6.

2. Lubricant Adhesive: ASTM Designation D 2835.

3. Install compression seals along with lubricant adhesive according to the manufacturer's recommendations. Submit manufacturer's recommendations to the Owner’s Representative.

B. Accompany each lot of compression seal and lubricant adhesive by a Certificate of Compliance, storage instructions and precautionary instructions for use. Also submit the manufacturer's data sheet with installation instructions and recommended model or type of preformed compression seal for the joint size and depth as shown on the plans. Show evidence that the selected seal is being compressed at level between 20 and 50 percent at all times for the joint width and depth shown on the plans.

2.7 BACKER RODS

A. Provide backer rods that have a diameter prior to placement at least 25 percent greater than the width of the saw cut after sawing and are expanded, crosslinked, closed-cell polyethylene foam that is compatible with the joint sealant so that no bond, adverse reaction occurs between the rod and sealant. In no case use a hot pour sealant that will

melt the backer rod. Submit a manufacturer's data sheet verifying that the backer rod is compatible with the sealant to be used.

PART 3 - EXECUTION
PART 2

3.1 WATER SUPPLY

A. Conform to Section 40-1.02 of Caltrans Standard Specifications.

3.2 SUBGRADE

A. Conform to Section 40-1.04 of Caltrans Standard Specifications.

3.3 SOIL STERILANT

A. Furnish and apply to areas indicated in accordance with Section 31 31 19 – Vegetation Control.

3.4 PLACING

A. Conform to Section 40-1.06 of Caltrans Standard Specifications.

3.5 SPREADING COMPACTING AND SHAPING

A. Conform to Section 40-1.07 of Caltrans Standard Specifications.

1. Stationary Side Form Construction: Section 40-1.07A of Caltrans Standard Specifications.

2. Slip Form Construction: Section 40-1.07B of Caltrans Standard Specifications.

3.6 INSTALLING TIE BARS

A. Install at longitudinal contact joints, longitudinal weakened plane joints, and transverse contact joints as shown on the plans. In no case, shall any consecutive width of new portland cement concrete pavement tied together with tie bars exceed 15 meters. In no case shall tie bars be used at a joint where portland cement concrete and asphalt concrete pavements abut.

B. Tie bars shall be installed at longitudinal joints by one of the 3 following methods:

1. Drilling and bonding in conformance with the details shown on the plans. Provide a two-component, epoxy-resin, conforming to the requirements of ASTM Designation: C 881, Type V. Grade 3 (Non-Sagging), Class shall be as follows:

Temperature of Concrete	Required Class of Epoxy Resin
Lower than 40° F (4.5 °C)	A
40˚ F (4.5˚ C) through 60˚ F (15.5˚ C)	B
Above 60˚ F (15.5˚ C)	C

2. Provide, at least 7 days prior to start of work, a Certificate of compliance and a copy of the manufacturer's recommended installation procedure. The drilled holes shall be cleaned in accordance with the epoxy manufacturer's instructions and shall be dry at the time of placing the epoxy and tie bars. Immediately after inserting the tie bars into the epoxy, the tie bars shall be supported as necessary to prevent movement during the curing and shall remain undisturbed until the epoxy has cured a minimum time as specified by the manufacturer. Tie bars that are improperly bonded, as determined by the Owner, will be rejected. If rejected, adjacent new holes shall be drilled, as directed by the Owner, and new tie bars shall be placed and securely bonded to the concrete. All work necessary to correct improperly bonded tie bars shall be performed at the Contractor's expense.

3. Insert the tie bars into the plastic slip-formed concrete before finishing the concrete. Inserted tie bars shall have full contact between the bar and the concrete. When tie bars are inserted through the pavement surface, the concrete over the tie bars shall be reworked and refinished to such an extent that there is no evidence on the surface of the completed pavement that there has been any insertion performed. Any loose tie bars shall be replaced by drilling and grouting into place with epoxy as described in method 1 above at the Contractor's expense.

4. By using threaded dowel splice couplers fabricated from deformed bar reinforcement material, free of external welding or machining. Threaded dowel splice couplers shall be accompanied by a Certificate of Compliance and installation instructions.. Installation of threaded dowel splice couplers shall conform to the requirements of the manufacturer's recommendations.

3.7 JOINTS

A. Conform to Section 40-1.08 of Caltrans Standard Specifications, Except that tie bars shall be as specified under Part 2, Products.

1. Transverse Contact Joints: Section 40-1.08A of Caltrans Standard Specifications.

   a. Construct a transverse contact (construction) joint at the end of each day's work, or where concrete placement is interrupted for more than 30 minutes, to coincide with the next weakened plane joint location.

   b. If sufficient concrete has not been mixed to form a slab to match the next weakened plane joint, when an interruption occurs, the excess concrete shall be removed and disposed of back to the last preceding joint. The cost of removing and disposing of any excess concrete shall be at the Contractor's expense. Any excess material shall be become the property of the Contractor and shall be properly disposed of.

   c. A metal or wooden bulkhead (header) shall be used to form the joint. The bulkhead shall be designed to accommodate the installation of tie bars.

2. Weakened Plane Joints: Section 40-1.08B, except that the insert method of forming joints in pavement shall not be used.

3.8 FINISHING

A. Conform to Sections 40-1.09 and 40-1.10 of Caltrans Standard Specifications.

3.9 CURING

A. Conform to Section 40-1.11 of Caltrans Standard Specifications.

3.10 SEALING JOINTS

A. Liquid Joint Sealant Installation.

1. The joint sealant detail for transverse and longitudinal joints, as shown on the plans, shall apply only to weakened plane joints. Construct weakened plane joints by the sawing method. Should grinding or grooving be required over or adjacent to any joint after sealant has been placed, completely remove the joint material and disposed of, and replace at the Contractor's expense. Recess sealant below the final finished surface as shown on the plans.

2. At the Contractor's option, transverse weakened plane joints shall be either Type DSC or Type SSC as shown on the plans. Longitudinal weakened plane joints shall be Type SSC only as shown on the plans.

3. Seven days after the concrete pavement placement and not more than 4 hours before placing backer rods and joint sealant materials, clean the joint walls by the dry sand blast method and other means as necessary to completely remove from the joint all objectionable material such as soil, asphalt, curing compound, paint and rust. After cleaning the joint, remove all traces of sand, dust and loose material from and near the joint for a distance along the pavement surfaces of at least 50 mm on each side of the joint by the use of a vacuum device. Remove surface moisture at the joints by means of compressed air or moderate hot compressed air or other means approved means. Do not use drying procedures that leave a residue or film on the joint wall. Sandblasting equipment shall have a maximum nozzle diameter size of 6 ± 1 mm and a minimum pressure of 0.62-MPa.

4. Install backer rod as shown on the plans. Provide an expanded, closed-cell polyethylene foam backer rod that is compatible with the joint sealant so that no bond or adverse reaction occurs between the rod and sealant. Install backer rod when the temperature of the portland cement concrete pavement is above the dew point of the air and when the air temperature is 4°C or above. Install backer rod when the joints to be sealed have been properly patched, cleaned and dried. Do not use a method of placing backer rod that leave a residue or film on the joint walls.

5. Immediately after placement of the backer rod, place the joint sealant in the clean, dry, prepared joints as shown on the plans. Apply the joint sealant by a mechanical device with a nozzle shaped to fit inside the joint to introduce the sealant from inside the joint. Apply adequate pressure to the sealant to ensure that the sealant material is extruded evenly and that full continuous contact is made with the joint walls. After application of the sealant recess the surface of the sealant as shown on the plans.

6. Any failure of the joint material in either adhesion or cohesion of the material will be cause for rejection of the joint. Conform the finished surface of joint sealant to the dimensions and allowable tolerances shown on the plans. Rejected joint materials or joint material whose finished surface does not conform to the dimensions shown on the plans shall be repaired or replaced, at the Contractor's expense, with joint material that conforms to the requirements.

7. After each joint is sealed, remove all surplus joint sealer on the pavement surface. Traffic shall not be permitted over the sealed joints until the sealant is tack free and set sufficiently to prevent embedment of roadway debris into the sealant.

B. Preformed Compression Joint Seal Installation

1. The compression seal alternative joint detail for transverse and longitudinal joints, as shown on the plans, shall apply only to weakened plane joints. Construct weakened plane joints by the sawing method. Should grinding or grooving be required over or adjacent to any joint after the compression seal has been placed, completely remove the joint materials and disposed of, and replace at the Contractor's expense. Compression seal shall be recessed below the final finished surface as shown on the plans.

2. At the Contractor's option, transverse weakened plane joints shall be either Type DSC or Type SSC as shown on the plans. Longitudinal weakened plane joints shall be Type SSC only as shown on the plans.

3. Seven days after the concrete pavement placement and not more than 4 hours before placing preformed compression joint seals, clean the joint walls by the dry sand blast method and other means as necessary to completely remove from the joint all objectionable material such as soil, asphalt, curing compound, paint and rust. After cleaning the joint, remove all traces of sand, dust and loose material from and near the joint for a distance along the pavement surfaces of at least 50 mm on each side of the joint by the use of a vacuum device. Remove surface moisture at the joints by means of compressed air or moderate hot compressed air or other means. Do not use drying procedures that leave a residue or film on the joint wall. Sandblasting equipment shall have a maximum nozzle diameter size of 6 ± 1 mm and a minimum pressure of 0.62-MPa.

3.11 PROTECTING CONCRETE PAVEMENT

A. Conform to Section 40-1.12 of Caltrans Standard Specifications.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Portland Cement Concrete curbs and gutters.

1.2 RELATED SECTIONS

A. Section 31 23 00 – Excavation and Fill

B. Section 31 31 19 – Vegetation Control

C. Section 32 11 00 – Base Courses

D. Section 32 13 00 – Rigid Paving

E. Section 32 05 23 – Cement and Concrete for Exterior Civil 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 considered to be designated by compressive strength. The 28-day compressive strength shown herein or on the plans which are less than 3,500 psi are shown for design information only and are not considered a requirement for acceptance of the concrete. Whenever the concrete is designated by class or as minor concrete herein or on the Plans, the concrete shall contain the cement per cubic yard shown in Section 90-1.01 of the Caltrans Standard Specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Comply with requirements of Section 32 05 23 – Cement and Concrete for Exterior Improvements.

2.2 PORTLAND CEMENT CONCRETE

A. Unless specified otherwise herein or on the Plans, Portland Cement Concrete for items in this section shall be Minor Concrete as specified in Section 90-1.01 of the Caltrans Standard Specifications.

2.3 CURBS AND GUTTERS FORMS

A. Use flexible spring-steel forms or laminated boards to form radius bends. Tolerance: Not to deviate more than 1/4 inch in 10 feet in grade and alignment.

2.4 EXPANSION JOINT MATERIAL

A. Material for expansion joints in portland cement concrete improvements shall be premolded expansion joint fillers conforming to the requirements of ASTM Designation D 1751. Expansion joint material shall be shaped to fit the cross section of the concrete prior to being placed. Suppliers certificates showing conformance with this specification shall be delivered with each shipment of materials delivered to the job site.

B. Unless noted otherwise herein or on the Plans expansion joint thickness shall be as follows:

1. Curbs, Curb Ramps, Island Paving, Driveways and Gutter Depressions: ¼-inch.

PART 3 - EXECUTION

3.1 GENERAL

A. Comply with requirements of Section 32 05 23 – Cement and Concrete for Exterior Improvements.

B. Form, place and finish concrete walkways, island paving, valley gutters and driveway approaches in conformance with the applicable requirements of Section 73-1.04 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. Provide a medium broom finish to all horizontal surfaces unless otherwise shown.

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 ½-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.

3.11 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

PART 1 - GENERAL

1.1 SUMMARY

A. Provide materials, fabrication, and installation of parking wheelstops and associated accessory items.

1.2 SUBMITTALS

A. Submit manufacturer's literature describing products and recommended installation details.

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

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 32 05 23 – Cement and Concrete for Exterior Improvements

1.3 RELATED DOCUMENTS

A. Caltrans Standard Specifications:

1. Section 56, Signs.
2. Section 81, Monuments.
3. Section 82, Markers and Delineators.
4. Section 84, Traffic Stripes and Pavement Markings.
5. Section 85, Pavement Markers.

B. Caltrans Standard Plans:

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Cast In Place Detectable/Tactile Warning Surface Tiles.

B. Surface Applied Detectable/Tactile Warning Surface Tiles.

1.3 RELATED SECTIONS

A. Section 32 1313 “Pedestrian Concrete Paving” for concrete walkways and finishes, aprons, curbs and gutters.

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 (CCR) 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".

D. 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.

B. Surface Applied 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 03 3000 "Cast-in-Place Concrete".

PART 2 - PRODUCTS
PART 1

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 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: [12x12] [24x24] [24x36] [24x48] [24x60] [36x48] [36x60] nominal, unless otherwise indicated.

4. Depth:
   a. Cast-In-Place - 1.375 (1-3/8”) (+/-) 5% max.
   b. Surface Applied – 0.1875(+/-) 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" center to center (for Cast-In-Place).

8. Color: Federal Color Number 33538. Color shall be homogeneous throughout the tile.

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± 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 ½” 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 (for Cast-In-Place).

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. Adhesive: Adhesive as supplied by manufacture.

C. Sealant: Sealant as supplied by manufacture.

PART 3 - EXECUTION
PART 2

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 SURFACE APPLIED INSTALLATION

A. During all surface preparation and Surface Applied 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. The application of all tiles, adhesives, mechanical fasteners, and caulking shall be in strict accordance with the guidelines set by their respective manufacturers. Not recommended for asphalt applications.

C. Coordinate with the Contractor or Engineer to ensure that the surfaces being prepared and fabricated to receive the tiles are constructed correctly and adequately for tile installation. Review manufacturer and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to the Engineer.

D. Set the tile true and square to the curb ramp area as detailed in the design drawings, so that its location can be marked on the concrete surface. A thin permanent marker works well. Remove tile when done marking its location.

E. The surface to receive the Surface Applied Detectable/Tactile Warning Surface Tile is to be mechanically cleaned with a diamond cup grinder or shot blaster to remove any dirt or foreign material. This cleaning and roughening of the concrete surface should include at least 4 inches around the perimeter of the area to receive the tile, and also along the cross pattern established by the corresponding areas on the backside of the tile. Those same areas should then be cleaned with a clean rag soaked in Acetone.

F. Immediately prior to installing the Surface Applied Detectable/Tactile Warning Surface Tile, the concrete surfaces must be inspected to ensure that they are clean, dry, free of voids, curing compounds, projections, loose material, dust, oil, grease, sealers and determined to be structurally sound and cured for a minimum of 30 days.

G. Using Acetone, wipe the backside of the tile around the perimeter and along the internal cross pattern, to remove any dirt or dust particles from the area to receive the adhesive.

H. Apply Armor-Bond adhesive to the backside of the tile, following the perimeter and internal cross pattern established by the tile manufacturer. Sufficient adhesive must be placed on the prescribed areas to have full coverage across the 2” width of the adhesive locator and shall be applied to within 1/4” continuously around the perimeter edge of the tile. The entire tube of adhesive shall be applied to the back of each tile, sizes 24” x 36”and greater.

I. Set the tile true and square to the curb ramp area as detailed in the design drawings.

J. Working from the center of the tile outwards, proceed to drill and install all fasteners in the tile’s molded recesses.

K. Standing with both feet applying pressure around the molded recess provided in the tile, drill a hole true and straight to a depth of 31/2” using a 1/4” masonry drill bit. Drill through the tile without hammer option (on the drill) until the tile has been successfully penetrated, then with hammer option (on the drill) to drill into the concrete. Maintaining foot pressure on both sides of the hole while drilling prevents concrete dust from accumulating between the tile and concrete which can affect the tile being installed flush and may compromise installation integrity.

L. Immediately after drilling each hole, before moving on to the next, and while still applying foot pressure, mechanically fasten tiles to the concrete substrate using a leather bound or hard plastic mallet to set the fasteners. Ensure the fastener has been placed to full depth in the dome, straight, and flush to the top of dome. Drive the pin of the fastener with the mallet, taking care to avoid any inadvertent blows to the truncated dome or tile surface.

M. Following the installation of the fasteners, the concrete dust should be vacuumed, brushed or blown away from the tile’s surface and adjacent concrete. Using Acetone on a rag, wipe the concrete around the tile’s perimeter to ensure a clean, dry surface to receive perimeter sealant.

N. Armor-Seal perimeter caulking sealant should be applied following the sealant manufacturer’s recommendations. Tape all perimeter edges of the tile back 1/16” from the tile’s perimeter edge and tape the adjacent concrete back 1/2” from the tile’s perimeter edge to maintain a straight and even caulking line. Apply sealant around tile perimeter using care to work sealant into any void between the tile and concrete interface. Tool the perimeter caulking with a rounded plastic applicator or spatula to create a cove profile between the tile and adjacent concrete. Remove tape immediately after tooling perimeter caulking sealant.

O. Do not allow foot traffic on installed tiles until the perimeter caulking sealant has cured sufficiently to avoid tracking. Curing time is weather dependent (average cure time at 75° F is 30 minutes). Adhesive or caulking on the surface of the Armor-Tile can be removed with Acetone.

P. If installing adjacent tiles, note the orientation of each tile. Careful attention will reveal that one of the long edges of the tile is different than the other in regard to the tiny dotted texture. You may also note a larger perimeter margin before the tiny dotted texture pattern begins. Consistent orientation of each Armor-Tile is required in order that the truncated domes on adjacent tiles line up with each other.

Q. In order to maintain proper spacing between truncated domes on adjacent tiles, the tapered edge should be trimmed off using a continuous rim diamond blade in a circular saw or mini-grinder. The use of a straightedge to guide the cut is required. All cuts should be made prior to installation of the tiles. If installing adjacent tiles, care should be taken to leave a 1/8 inch gap between each tile to allow for expansion and contraction.

R. If tiles are custom cut to size, if pre-molded recesses (to receive fasteners) are removed by the cut, or to maintain a tight installation to the substrate then any truncated dome can be center-drilled with a 1/4 inch masonry drill bit to create a through hole, and the through hole must be countersunk with a suitable carbide countersink bit to receive mechanical

fasteners. Care should be taken to not countersink too widely or deeply. Fasteners should be flush with the top of the truncated dome when countersunk properly.

3.4 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

32 84 00 IRRIGATION

PART 1 -GENERAL

1.1 SUMMARY

A. Section Includes: All labor, materials, supplies, tools and transportation to perform all operations in connection with and reasonably incidental to the complete installation of the automatic sprinkler irrigation systems as shown on the Drawings.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS:

A. Final Acceptance for Work of this Section is contingent on completion of Work of Section 32 90 00.

B. Division 26 - Electrical power to controller.

C. Division 32 – Exterior Improvements: Irrigation sleeving under paving.

D. Division 33 – Utilities: Water meter and stub-out installation.

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials
   1. A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. D1785 – Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40 and 80 and Classes 200 and 315.

B. ICC – International Code Council

C. NEC – National Electric Code

D. State of California, Division of Industrial Safety
   1. Electrical Safety Orders

E. UPC – Uniform Plumbing Code

1.4 QUALITY ASSURANCE

A. OSHA Compliance:
   1. All articles and services covered by this Specification shall meet or exceed the safety standards established under the Federal Occupational Safety and Health Act of 1970, together with all amendments in effect as of the date of this Specification.
   2. The subcontractor shall erect and maintain barricades, guards, warning signs, and lights as necessary or required by OSHA regulations for the protection of the

public or workmen.

B. Regulatory requirements: In addition to complying with all pertinent codes and regulations, comply with the latest rules of NEC and the Electrical Safety Orders of the State of California, Division of Industrial Safety, for all electrical work and materials. The materials and methods to be used in constructing the irrigation system shall conform to the applicable provisions of the UPC.

C. When the Specifications call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, the provision of the Specifications shall take precedence over the requirements of the said rules and regulations.

D. The subcontractor shall furnish without any extra charge any additional material and labor when required by the compliance with these rules and regulations, though the work be not mentioned in these particular Specifications or shown on the Drawings.

E. Any existing buildings, equipment, piping, pipe covering sewers, sidewalks, landscaping, etc., damaged by the subcontractor during the course of his work shall be replaced or repaired by the subcontractor in a manner satisfactory to the Owner's Agent and at subcontractor's own expense, and before the final payment is made. The subcontractor shall be responsible for damage caused by leaks in the piping systems being installed by him. He shall repair, at his own expense, all damage so caused, in a manner satisfactory to the Owner's Agent.

F. The subcontractor, personally or through an authorized and competent representative, shall supervise the work constantly, and shall as far as possible keep the same foreman and workmen on the job from commencement to completion. The workmanship of the entire job must in every way be first class, and only experienced and competent workmen will be allowed on the job.

G. The subcontractor shall pay for all permits, licenses, and fees required.

H. Pre-construction conference: Contractor shall schedule and conduct a conference to review in detail quality control and construction requirements for equipment, materials, and systems used to perform the work. The conference shall be scheduled not less than 10 days prior to commencement of work. All parties required to be in attendance shall be notified no later than 7 days prior to date of conference.

1.5 SUBMITTALS

A. Materials List: Within 15 days after award of contract and prior to installation, submit six copies of materials list. Include manufacturer, model number, and description of all materials and equipment. Include sealants, cements, lubricants and other proprietary items.

B. Substitutions: Submit six copies of catalog information on materials which are to be submitted for substitution. No substitution will be permitted without prior written approval by the Architect. A complete material list shall be submitted prior to performing any work.

C. Record Drawings:
   1. The subcontractor shall maintain in good order, in the field office, one complete set of blue line prints of all irrigation drawings which form a part of the Contract, showing all water lines, sprinklers, valves, controllers and stub-outs. Any work not installed as indicated on the Drawings, shall be recorded and dimensioned accurately from the building walls on these prints. All as-built markups shall be indicated in red.
   2. All underground stub-outs for future connections and valves shall be located and dimensioned accurately from building walls on these record drawings.
   3. Upon completion of the work, obtain reproducible prints from Architect and neatly correct the prints to show the as-built conditions.

D. Controller Charts:
   1. Record Drawings shall be accepted by Architect before controller charts are prepared.
   2. Provide one controller chart for each controller supplied.
   3. Charts shall be the maximum size that the controller door will allow, showing areas covered by each controller. Chart shall be an electrostatic copy and a different color shall be used to indicate area of coverage for each station. Enlarge valve sequence to be readable when drawing is reduced.
   4. After being completed and accepted, seal by plastic laminating. Laminating sheets shall be a minimum of 10 mil thick.

E. Operations and maintenance manuals:
   1. Deliver to owner at least 10 days prior to completion of construction, 2 complete sets of the following data. Data shall be on 8 1/2 inch by 11 inch sheets, in a 3-ring binder.
      a. Index sheet stating Contractor's address and telephone number and list of equipment with name and addresses of local manufacturer's representatives.
      b. Catalog and parts sheets on all material and equipment installed under this Section.
      c. Complete operating and maintenance instructions for all equipment.
      d. Complete and dated manufacturer's warranties for all materials used.
   2. Irrigation Maintenance Schedule to include, but not be limited to, routine inspection, adjustment, and repair of the irrigation system and its components.

1.6 LAYOUT OF WORK

A. The irrigation contractor shall stake out the irrigation system as shown on the Drawings. Stakes shall be approved by Landscape Architect before construction is started. Any changes, deletions or additions shall be determined at this check.

1.7 INSTRUCTION

A. After the system has been installed and approved, subcontractor shall instruct the Owner's representative in complete operation and maintenance of the irrigation system.

1.8 WARRANTY

A. Provide 1 year guarantee for Work of this Section in accordance with Section 1700.

B. Provide supplemental guarantee, on Contractor's letterhead:
   1. Warrant that irrigation system has been installed according to Drawings and Specifications, and that system will be free of defects in products and installation for 1 year from Substantial Completion. Manufacturer's warranties shall only supplement special warranty.
   2. Agree to repair or replace defective Work, or adjacent work which is damaged by such defects, with the exception of ordinary wear and tear, abuse or neglect. This includes damage to site improvements caused by settlement of improperly compacted trench backfill.
   3. Owner reserves the right to make temporary repairs as required.

PART 2 - MATERIALS

2.1 PIPE AND FITTINGS

A. Main lines (constant pressure) 2 inch shall be PVC 1120 Schedule 40 solvent weld pipe, Type 1, and shall conform to ASTM D1785. Use Schedule 40 and Schedule 80 PVC solvent weld fittings.

B. Lateral lines (non pressure) shall be 1120 Schedule 40 PVC plastic pipe Type 1, and shall conform to ASTM D1785. Use Schedule 40 PVC solvent weld fittings.

C. Metal Pipe:
   1. Steel pipe shall be Schedule 40 galvanized steel conforming to ASTM 53B. Metal pipe shall be wrapped in 2 inch wide, 20 mil thick, black PVC all weather corrosion-resistant tape with high tack adhesive. Use threaded galvanized steel fittings.
   2. Provide dielectric fittings where dissimilar metals come into contact.

D. Fittings:
   1. Solvent Weld socket fittings: Schedule 40, Type 1, Grade 1, PVC and shall conform to ASTM D2466. Schedule 80, Type 1, Grade 1 PVC and shall conform to ASTM D2467. Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type recommended by pipe manufacturer.

E. Connections between main lines and remote control valves shall be of Schedule 80 PVC (threaded both ends) nipples and fittings.

F. Risers shall be as follows: Schedule 80 PVC threaded nipples and Schedule 80 PVC ells as shown on the construction details.

2.2 QUICK COUPLING VALVES

A. Quick Coupling valves shall be bronze construction, 1-inch connection, two-piece body, locking purple vinyl top, single slot and lug. Provide 1-inch single lug key and 3/4-inch hose swivel.

B. Quick Coupling valves shall be restrained with cast iron restrainers that attach securely to the base of the valve. Restrainers shall make contact with the hex flats of the valve and be secured by a single bolt.

2.3 GATE VALVES

A. 2½ inch and smaller shall be bronze construction conforming to ASTM B 62 with screw-in bonnet, non-rising stem, operating wheel and threaded connections.

2.4 BALL VALVES

A. Ball valves shall be Schedule 80 PVC full port design. PVC ball valves to be installed upstream of each remote control valve.

2.5 REMOTE CONTROL VALVES

A. Remote control valves shall be globe pattern constructed of heavy duty glass-filled nylon and stainless steel with internal and external bleed. Operating pressure shall be 10 to 150 psi and flow range shall be .1-180 gpm. All internal parts shall be removable from the top.

B. Each valve shall have a plastic tag denoting its controller and station number.

2.6 MASTER REMOTE CONTROL VALVE

A. Master remote control valve shall be constructed of heavy duty cast iron, bronze, stainless steel, and copper with metering pin and manual flow stem to adjust closing speed. Operating pressure shall be 3 to 300 psi and flow range shall be .01 to 3000 gpm.

B. Master Valve shall be normally open.

2.7 FLOW SENSOR

A. Flow sensors shall be capable of sensing programmed water flows during the operation of the irrigation system and shall be capable of detecting excess or inadequate water flows as per the operator entered parameters.

B. The flow sensors shall be compatible with the irrigation controller and shall be capable of transmitting water flow information to the irrigation controller.

C. The flow sensor shall meet the following requirements:
   1. Tee shall be PVC with sensor pre-installed.
   2. Insertion type with a non magnetic, spinning impeller as the only moving part.
   3. Rated for a maximum line pressure of 150 psi and a maximum liquid temperature of 140 degrees F.
   4. Accuracy of plus or minus 1 percent of full scale, linearity of plus or minus 1 percent, repeatability of plus or minus 1 percent, and a flow range of 1 to 30 feet per second.

2.8 CONTROLLERS

A. Controllers shall be as listed on the Drawings and shall have the following features:
   1. Utilize ET manager for irrigation scheduling.
   2. UL listed, solid state, capable of automatic or manual operation.
   3. Non-volatile memory.
   4. Scheduling with 365 day calendar, odd/even watering, and rain delay of 1-14 days.
   5. Cycle and soak feature.
   6. Compatible with master valve and flow sensor.
   7. Hand held remote ready.

B. Hand held remote shall be compatible with controller.

2.9 CONTROL WIRE

A. Copper with UL approval for direct burial in ground, size #12-1 for common wire and size #14-1 for control wire. Common ground wire shall have white insulating jacket; control wire shall have insulating jacket of color other than white. Provide a separate ground wire for each controller.

B. Splices shall be made with 3M DBR/Y-6 connectors.

2.10 VALVE BOXES

A. High density polyethylene construction with UV inhibitors. Lid shall be green in color and have stainless steel bolt-down mechanism. Boxes, lids, and bolts shall be from the same manufacturer. Plastic valve boxes shall be by Carson, NDS Pro Series, or equal.

B. The lid shall be marked as follows:
   1. Remote Control Valves – “Irrigation Control Valve” or “ICV” with the station number in one inch (1”) high white enamel or heat branded numbers and letters.
   2. All other valves - “Irrigation Control Valve” or “ICV”.

C. Valve box sizes are noted on drawing details.

2.11 BUBBLERS

A. Bubblers shall be as listed on the Drawings and shall be pressure compensating.

2.12 DRIP SYSTEM

A. Provide all components required for complete system:
   1. Wye Filter: Corrosion resistant plastic housing, 1inch FIPT/MIPT connections with removable stainless steel screen and integral flush valve with hose threads. Screen shall be 150 mesh.
   2. Pressure regulator: Constructed of thermoplastic with stainless steel compression spring and securing screws. Pre-set to maintain constant outlet pressure of 30 psi.

2.13 SUBSURFACE IRRIGATION

A. Dripline tubing and pressure compensating emitters shall be extruded from linear low-density polyethylene. Tubing shall have a minimum nominal diameter of ½ inch with a minimum wall thickness of 0.045. Protection from root intrusion shall be provided by means of impregnation of non-toxic pre-emergent in pipe during the manufacturing process.

B. All accessories listed below shall be furnished by the same manufacturer as the dripline.
   1. Line Flushing Valves – the subsurface irrigation system shall utilize automatic line flush valves at the end of each independent zone area. This valve shall be capable of flushing one gallon at the beginning of each irrigation cycle. The valves shall connect directly to the dripline.
   2. Air/Vacuum Relief Valve – each independent irrigation zone shall utilize an air/vacuum relief valve at its high point. The air and vacuum relief valve shall seal effectively from 2 to 10 psi.

2.14 BACKFLOW PREVENTION DEVICE

A. Backflow prevention device shall be the reduced pressure type with gate valves, check valves, test cocks, reduced pressure chamber, and air vent.

B. Backflow preventer enclosure shall be cold rolled steel with green powder coating, 1/8 inch wall thickness, with stainless steel hardware. Enclosure shall be removable from base without use of tools. Enclosure shall be sized to fit backflow prevention device.

2.15 MISCELLANEOUS INSTALLATION MATERIALS

A. Solvent cement and primer for solvent weld joints shall be of make and type approved by manufacturer(s) of pipe and fittings. Cement shall be maintained at proper consistency throughout use.

B. Pipe joint compound shall be non-hardening, non-toxic materials designed specifically for use on threaded connections in water carrying pipe. Performance shall be same as Rector Seal 100 W.

C. Drain rock: 3/4 inch washed pea gravel.

2.16 MISCELLANEOUS EQUIPMENT

A. Provide all equipment called for by the Drawings.

B. Provide to the Owner, at completion of the Maintenance Period, three (3) each of all operating and servicing keys and wrenches required for complete maintenance and operation of all heads and valves. Include all wrenches necessary for complete disassembly of all heads and valves.

C. Provide two (2) each of quick coupler keys and hose swivels and three (3) sets of keys to both controller cabinets and enclosures.

PART 3 - INSTALLATION

3.1 PREPARATION

A. Schedule and coordinate placement of materials and equipment in a manner to effect the earliest completion of work in conformance with construction and progress schedule.

B. Contractor shall field verify the static water pressure at the project site prior to commencing work or ordering irrigation materials. If contractor fails to verify static water pressure prior to commencing work, contractor shall assume responsibility for all costs required to make system operational.

C. Examine areas and conditions under which work of this section is to be performed. Do not proceed with work until necessary conditions have been corrected.

3.2 HANDLING AND STORAGE

A. Protect work and materials from damage during construction and storage as directed by Architect.

B. Handle plastic pipe carefully; especially protecting it from prolonged exposure to sunlight.

C. Store sub-surface dripline and polyethylene tubing in cool dry place out of sunlight during installation.

3.3 LAYOUT

A. Layout work as accurately as possible in accordance with diagrammatic drawings.

B. Where site conditions do not permit location of piping, valves and heads where shown, notify Architect immediately and determine relocation in a joint conference.

C. Run pipelines and automatic control wiring in common trenches whenever practical.

3.4 EXCAVATING AND TRENCHING

A. Excavation shall be in all cases ample in size to permit the pipes to be laid at the elevations intended and to permit ample space for joining.

B. Depth of trenches shall be enough to provide minimum cover from finish grade to top of pipe in trenches, as follows:

1. 18 inch minimum cover over main lines to the control valves and quick coupling valves.
2. 18 inch minimum cover over direct burial control wires from controller to valves.
3. 12 inch minimum cover over the valve controlled lines to sprinkler heads.

4. 24 inch minimum cover over sleeves.

C. Restore surfaces, existing underground installations, etc., damaged or cut as a result of excavations, to original conditions in a manner approved by the Architect.

D. Where other utilities interfere with irrigation trenching and pipe work, adjust the trench depth as instructed by Architect.

3.5 ASSEMBLING PIPELINES

A. All pipes shall be assembled free from dirt and pipe scale. Field cut ends shall be reamed only to full pipe diameter with rough edges and burrs removed.

B. Solvent Weld Joint:
1. Prepare joint by first making sure the pipe end is square, then deburring the pipe end and cleaning the pipe and fitting of dirt.
2. Dry-insert pipe into fitting to check for missizing. Pipe should enter fitting 1/3 to 2/3 depth of socket.
3. Coat the inside socket surface of the fitting and the external surface of the male end of the pipe with P-70 primer (manufactured by Weld-On), immediately followed by Weld-On 711 cement liberally applied to the male end of the pipe and lightly applied to the inside of the socket. Then, apply a second coat of cement to the pipe end.
4. Insert pipe immediately into fitting and turn it 90° to distribute cement and remove air bubbles. The pipe must seat to the bottom of the socket and fitting. Check alignment of the fitting. Pipe and fitting shall be aligned properly without strain to either.
5. Hold joint still for approximately thirty (30) seconds and then wipe the excess cement from the pipe and fitting.
6. Cure joint a minimum of thirty (30) minutes before handling and at least six (6) hours before allowing water in the pipe.

C. Threaded Joint:
1. Field threading of plastic pipe or fittings is not permitted. Factory-formed threads only will be permitted.
2. Factory-made nipples shall be used wherever possible. Field-cut threads in metallic pipe will be permitted only where absolutely necessary. When field threading, cut threads accurately on the axis with sharp dies.
3. All threaded joints shall be made up with pipe joint compound. Apply compound to male threads only.
4. Where assembling metallic pipe to metallic fitting or valve, no more than three (3) full threads shall show when joint is made up.
5. Where assembling to threaded plastic fitting, take up joint no more than one full turn beyond hand tightening.
6. Where assembling soft metal (brass or copper) or plastic pipe, use a strap type friction wrench only; do not use a metal-jawed wrench.

D. Cap or unplug openings as pipeline is assembled to prevent entrance of dirt or obstruction. Remove caps or plugs only when necessary to continue assembly.

E. Where pipes or control wires pass through sleeves, provide a removable non-decaying plug at ends of sleeve to prevent entrance of earth.

3.6 REMOTE CONTROL VALVES

A. Install where shown on Drawings and group together where practical. Limit one remote control valve per box with no exceptions.

B. Locate valve boxes 12 inches from and perpendicular to walk edges, buildings and walls. Provide 12 inches between valve boxes where valves are grouped together.

C. Thoroughly flush main line before installing the valve.

D. Install in shrub or ground cover areas where possible.

E. Label control line wire at each valve with a 2½" x 2½" polyurethane I.D. tag, indicating identification number of the valve (controller and station number). Attach a label to control wire.

3.7 QUICK COUPLING VALVES

A. Install quick coupling valves on double swing-joint assemblies of Schedule 80 PVC risers and fittings.

B. Thoroughly flush main line before installing the valve.

C. Install 12 inch from hardscape areas.

3.8 VALVE BOXES

A. Install one valve box for each type of valve unless otherwise noted.

B. Install boxes 12 inches from walk or header and 12 inches apart. Short side of rectangular boxes shall be parallel to walk or header. Install 2 inches above finish grade in groundcover areas and flush with grade in lawn areas.

C. Install common bricks as shown and as required to keep box stable. Install gravel sump after compaction of all trenches.

3.9 FLOW SENSOR

A. Install flow sensor a minimum of 10 times pipe diameter upstream and 5 times pipe diameter downstream of any valves, fittings, pipe bends, etc.

B. Use only sensor cable approved by the controller manufacturer. Install cable in a separate 1 inch conduit routed to controller. Leave enough flexibility in the cable to allow for future service of sensor.

3.10 BUBBLERS

A. Thoroughly flush lines before installing drip tubing or bubblers.

B. Locate bubblers as shown in the Drawings and Detail.

3.11 SUB-SURFACE IRRIGATION

A. Install per manufacturer's instructions.

B. Install dripline in a grid pattern 4 inch below finish grade.

C. Install air/vacuum relief valve at the highest point of each circuit on a line that is perpendicular to the dripline rows (exhaust header or lateral connecting dripline.) Install in 6 inch round valve box.

D. Install automatic flush valve at a point farthest away from source or along exhaust header. Install in 6 inch round valve box.

3.12 AUTOMATIC CONTROL WIRING

A. Run lines along mains where practical. Tie wires in bundles with pipe wrapping tape at 10' intervals and allow slack for contraction between strappings.

B. Loop a minimum of three (3) feet of extra wire in each valve box; both control wire and ground wire.

C. Connections shall be made as shown on plans.

D. Splicing will be permitted only on runs exceeding 2500'. Locate all splices at valve locations within valve boxes.

E. Where control lines pass under paving, they shall pass through Schedule 40 electrical PVC conduit.

F. Common wire and control wires shall be tagged with 1/4" wide embossed plastic labeling tape, showing controller and station number designation.

3.13 AUTOMATIC CONTROLLER

A. Provide and install automatic irrigation controller in approximate locations shown on Drawings. The exact location will be determined on the site by Architect. Provide conduit and wire and connect to 120 volt switch accessible to controller for ease of maintenance.

B. Connect control lines to controller in sequential arrangement according to assigned identification number of the valve. Each control line wire shall be labeled at controller with a permanent non-fading label indicating station number of the valve controlled. Attach label to control wire.

C. Contractor is responsible for programming the controller. Provide optimum amounts of water for each plant type to maintain plants in vigorous healthy condition.

Reprogram as required at end of maintenance period.

3.14 BACKFLOW PREVENTION ASSEMBLY

A. Local codes shall govern installation requirements.

B. Install a minimum of 12 inches and a maximum of 30 inches above grade.

C. Install enclosure on concrete pad as shown on drawings.

3.15 BACKFILLING

A. Backfill only after piping has been tested, inspected and approved.

B. Backfill material shall be the earth excavated from the trenches, free from rocks, concrete chunks, and other foreign or coarse materials. Carefully select backfill that is to be placed next to plastic pipe to avoid any sharp objects which may damage the pipe.

C. All pipe under asphalt paving shall be backfilled with 4 inches of clean sand on all sides of pipe.

D. Place backfill materials in 6 inch layers and compact by jetting or tamping to a minimum compaction of 90 percent of original soil density.

E. Dress off areas to finish grades and remove excess soil, rocks or debris remaining after backfill is completed.

F. If settlement occurs along trenches, and adjustments in pipes, valves and sprinkler heads, soil, sod or paving are necessary to bring the system, soil, sod, or paving to the proper level or the permanent grade, subcontractor, as part of the work under this Contract, shall make all adjustments without extra cost to the Owner.

3.16 PIPE TESTS

A. Notify Architect at least three (3) days in advance of testing.

B. Perform testing at his own expense

C. Center load piping with a small amount of backfill to prevent arching or slipping under pressure. No fitting shall be covered.

D. Apply the following tests after weld plastic pipe joints have cured at least 24 hours.
   1. Test live (constant pressure) and quick coupling valve lines hydrostatically at 125 PSI minimum. Lines shall be filled with water and pressure gauge connected to the pipe line. After lines have reached the 125 PSI, (use hydraulic pump or other safe method – do not use an air compressor) cut off the source of pressure. Lines will be approved if test pressure (with an allowable drop of 2 PSI) is maintained for two (2) hours. Should leaks develop during the test period, they shall be located and repaired and retested in the same method. The subcontractor shall make tests

and repairs as necessary until test conditions are met.
2. Test remote control valve controlled lines with water at line pressure and visually inspect for leaks. Retest after correcting defects.

E. Remake faulty joints with new materials. Do not use cement or caulking to seal leaks.

3.17 SYSTEM ADJUSTMENT

A. Adjust pressure regulating modules to proper and similar pressure to provide optimum and efficient coverage.

B. Flush and adjust sprinkler heads for optimum performance. Prevent overspray onto walks, roadways, paving and buildings. Adjust nozzle sizes and degree of arc and install pressure compensating screens as required to cover planting areas without overspray. Adjust valve flow controls.

C. Drip System Check
1. Immediately after installation, flush lateral line piping by removing automatic flush valve.
2. Clean filter screens. Open filter flush valve for at least 10 seconds. Clean or replace clogged elements
3. Adjust pressure regulator to system design pressure.

D. Bubbler Check
1. Perform coverage test in the presence of Architect to establish that coverage of all planting areas is complete and adequate.
2. Correct deficiencies and repeat test until approved.

3.18 GUARANTEE

A. It shall be the responsibility of subcontractor to fill and repair all depressions and replace all necessary lawn and planting due to the settlement of irrigation trenches for one year following completion and acceptance of the job.

B. The subcontractor shall also guarantee all materials, equipment and workmanship furnished by him to be free of all defects of workmanship and materials, and shall agree to replace at his expense, at any time within one year after installation is accepted, any and all defective parts that may be found.

3.19 CLEANUP

A. When work of this section has been completed, and at such other times as may be directed, remove all trash, debris, surplus materials and equipment from the site.

END OF SECTION

32 90 00 PLANTING

PART 1 – GENERAL

1.1 SCOPE

A. Furnish all labor, equipment and materials necessary for soil sampling and testing, top soil placement, soil preparation, planting and maintenance period as shown and specified.

1.2 APPLICABLE DOCUMENTS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this Specification to the extent indicated by the references thereto:

1. American National Standards Institute (ANSI) Publications:
   a. ANSI Z60.1 - 1973, Nursery Stock.
   b. ANSI Z133.1 - 1972, Safety Requirements for Tree Pruning, Trimming, Repairing or Removal.
2. American Joint Committee on Horticultural Nomenclature Publications:
   a. Second Edition l972, Standardized Plant Names.

1.3 WORK SPECIFIED UNDER OTHER SECTIONS

A. Consult all other sections to determine extent and character of work specified elsewhere but related to that included in this section. Work specified herein shall be properly coordinated with that specified.

B. See General Provisions for Landscape Maintenance Bond requirements.

1.4 SUBMITTALS

A. Product data: For each of the following:

1. Compost: Cut sheet verifying feedstock and source.
2. Mulch: Cut sheet verifying feedstock type and producer.

Materials installed or furnished without prior acceptance by the Owners Representative may be rejected and if so will be removed from the site by the Contractor.

B. Product Sample: The following items shall be submitted in a 1 pint minimum volume of each in sealed plastic bag or container. Submittal shall be labeled with weight and source of each item. Each submittal shall represent a true sample of material to be provided at the project site.

1. Import soil.

3. Planter box back fill mix
4. Succulent soil mix.
5. Soil amendment / compost.
6. Mulch.
7. Top dressing for succulent planting areas.

C. Soil analysis: 0.5 cubic foot sample each of representative site soil and/or fill soil which will be in contact with plant roots and import topsoil. Samples shall not be taken under saturated conditions and shall wait at least 48 hours after rain or irrigation stops. Contractor shall submit soil samples to Waypoint Analytical, Inc., 1101 S Winchester Blvd., #G173, San Jose, CA 95128-3917 (408) 727-0330. Request test No. A 05, including: soil fertility - pH, salinity, nitrate, ammonium, phosphate, calcium, magnesium; agricultural suitability - boron, sodium, absorption ratio (SAR); particle size appraisal - organic content, USDA particle size distribution. Request soil lab to make recommendations for amending the soil with compost to bring the soil organic matter to a minimum of 5% by dry weight and incorporating natural, non-synthetic fertilizers to recommended levels for planting area.

D. Copy of order from Contractor to supplier for plant materials.

E. Prior to planting submit copies of all trucking or packaging tags to Landscape Architect for all soil amendment, fertilizer and other additives so that quantities may be verified.

1.5 SUBSTITUTIONS

A. Any substitutions of materials for any reason shall have prior approval from Landscape Architect.

1.6 STORAGE

A. Plants not installed on the day of arrival at the site shall be stored and protected as follows:

1. Outside storage shall be shaded and protected from the sun and wind.
2. Plants stored on the project shall be protected from drying out at all times by covering the balls or roots with moist sawdust, wood chips, shredded bark, peat moss or other similar mulching material.
3. Plants, including those in containers, shall be kept in a moist condition until planted, by watering.
4. Lime, fertilizer, soil sterilant or herbicide shall not be stored with any other landscape materials.

B. Storage of materials shall be only in areas designated or as approved by the Owner.

C. Handling - Care shall be taken to avoid damaging plants being moved from the nursery or storage area to the planting site. Plants shall be protected from drying out. Plants shall not be handled by the trunk or stem. Plants shall be protected from freezing or

drying out by a covering of burlap, tarpaulin, mulching material during transportation from the heeling-in bed to the planting site. Damaged plants shall be rejected and shall be removed from the site.

1.7 QUALITY STANDARDS

A. All work to be in accordance with the latest Safety Orders of the Division of Industrial Safety, O.S.H.A., and applicable State and local laws or regulations.

1.8 TIMELY ORDER OF PLANT MATERIALS

In order to receive plant materials in a timely fashion, Contractor shall order plant materials within ten (10) days of the Notice to Proceed and provide evidence of same as indicated in Item 1.4-A.8 above. Any potential delays in delivery or requests for substitution shall be brought to the attention of the Owner's Representative immediately.

PART 2 – PRODUCTS

2.1 DRAINAGE

A. Under succulent plant areas use 3 or 4-inch diameter, single wall, flexible, perforated drain lines conforming to Caltrans Specifications Section 68, Product may be ADS or equal.

B. Drain rock shall be per Caltrans Specifications Section 68, Class 2 Permeable Material.

C. Filter fabric for wrapping perforated drain lines shall be Mirafi 140N.

2.2 IMPORT SOIL

A. The import soil, if needed for general plant areas, shall sustain healthy plant life, without admixture of subsoil, free from rocks larger than 1-inch size, sticks and other foreign matter. Imported soil shall be USDA classification of sandy loam, sandy clay loam or loam with maximum gravel content no more than 15 percent, rock content no more than 5 percent and maximum organic content no more than 15 percent.

B. Submittal of import soil shall include a soil fertility test and amendment/fertilizer recommendations as specified in Section 1.4-A.1.

2.3 PLANTER BOX BACK FILL MIX

A. Mix the following components: 50% import soil, 30% sand and 20% compost/soil amendment. Soil weight shall be no greater than 100-lbs per cubic foot when wet.

B. Import soil shall be as specified under section 2.2.

C. Sand shall be a coarse builder's sand with particle size no finer than #2/12.

D. Compost shall be as specified below under 2.6 Soil Amendment,

2.4 SUCCULENT SOIL MIX

A. Mix the following components: 40% import or native soil, 25% perlite, 20% sand and 15% compost. At Contractor's option, succulent mix using the following components can be mixed by a commercial soil operation such as American Soil or equal.

B. Perlite shall be horticultural grade.

C. Sand shall be a coarse builder's sand with particle size no finer than #2/12.

D. Compost shall be as specified below under 2.6 Soil Amendment,

2.5 FERTILIZER

A. Fertilizers shall be non-synthetic as recommended by the soils report. Synthetic, quick-release fertilizers shall not be permitted. Fertilizers prohibited in the Generic Materials List by the Organic materials Review Institute (OMRI) are prohibited in the project.

B. Submit the list and/or cut sheets of fertilizers to be used.

2.6 SOIL AMENDMENT

A. Soil amendment, unless specified in the soil test result, shall be organic yard compost. Compost shall be well-decomposed, mature, stable and weed free. It shall not contain mixed solid waste. The product shall contain no substances toxic to plants, will possess no objectionable odors and shall not resemble the feedstock (the original material from which it was derived). Compost shall be tested through the US Composting Councils USCC Seal of Testing Assurance Program (STA).

2.7 MULCH

A. Mulch shall be an interlocking mix of wood particles in varying sizes from two-inches and smaller derived from tree and shrub trimmings aged for several weeks. No Eucalyptus sources are permitted. The mulch supplier shall be a member of the U.S. Composting Council that adheres to the standards of the Seal of Testing Assurance Program (STA). Make sure mulch size is appropriate to ground cover size.

2.8 TOP DRESSING FOR SUCCULENT PLANTING

A. Crushed rock. Tan-colored, angular rock graded to sizes .25-inch minus.

2.9 PLANT MATERIALS

A. Quality and size shall conform to best nursery practice. Nursery grown stock only shall be used. Secure Landscape Architect's approval for quality and size of all plant materials.

B. Measurements shall be as shown; where not shown shall be of uniform and standard size -- neither over-grown and root bound nor too recently canned so that the root system is not thoroughly established throughout the can. Pruning shall not be done prior to delivery except by approval.

C. Contractor shall be responsible for inspection of plant materials required by the Owner at any time before and during progress of the work. Rejected plants shall be removed from the site immediately.

D. Contractor shall adequately protect plants from sun and wind, on site and in transit.

E. Plant label shall identify each species and variety. Substitutions are not desired; requests for substitution shall be made at least 14 days prior to ordering.

F. Quantities necessary to complete the work as shown on the Drawings shall be furnished. Quantities shown on Planting Plan and Schedule are estimate only and shown for convenience of the Contractor.

PART 3 – EXECUTION

3.1 TREE AND SHRUB PLANTING

A. Place trees and shrubs in locations shown on plans. Secure approval of Landscape Architect prior to excavating pits.

B. Dig pits as detailed on drawings. After pits are dug, break sides to open wall of pit for root penetration.

C. Backfill in planting holes shall be a mixture of loose soil in a finely divided condition free from rocks or clods, thoroughly mixed with an equal volume of soil amendment.

D. Set top of plant ball 2 inches above finish grade. Backfill per drawings and thoroughly saturate to full depth of hole. Build basins and mulch per drawings. Stake per drawings.

3.2 GROUNDCOVER PLANTING

A. Scarify planting area and completely break-up soil to a depth of 6 inches.

B. Spread soil amendment at the rate of 6 cubic yards per 1000 square feet, till into the top 4 inches of soil. Rake to a smooth even surface.

C. Place 3 inch mulch in all groundcover and shrub areas between plants. Make sure mulch depth is appropriate to ground cover being used.

3.3 SUCCULENT PLANTING

A. Install perforated drain lines in succulent planting areas as shown on plan and details.

B. Place well-mixed soil components per Section 2.2, above, into succulent planting areas. Bring soil level to within one-inch of the upper lip of the plant container as the soil mix will shrink over time due to disintegration of the compost material.

C. Plant succulent container stock so that base of rootball is well supported and unlikely to settle relative to the soil surface over time. Crown of plant should be a little higher than soil surface.

3.4 PRELIMINARY INSPECTION

A. Contractor shall request Preliminary Inspection after completion of all planting. Approval of Preliminary Inspection establishes beginning of the Maintenance Period. No partial approvals will be given.

3.5 MAINTENANCE

A. Maintenance Period shall include all planting work and extend one hundred eighty (180) calendar days after approval at Preliminary Inspection.

B. Maintain as specified after acceptance in a vigorous, thriving condition by watering, pruning, cultivating, spraying and other necessary operations.

C. Protect from damage by erosion or trespass and provide proper safeguards or temporary fence.

D. Replace unhealthy, damaged plants promptly with material as specified.

E. Maintain constant moisture to an 8" depth.

F. Keep areas free of undesirable weeds by hand pulling.

G. Fertilize groundcover areas at the rate of 15 pounds per 1000 square feet. Water thoroughly into soil.

3.6 CLEAN-UP AND FINAL INSPECTION

A. Final Inspection for approval and acceptance of the project shall be made by the Landscape Architect at the conclusion of the maintenance period.

B. Prior to being considered ready for inspection, Contractor shall have made all corrections and repairs and have the job cleared of all weeds and debris and presented in a neat, orderly fashion.

3.7 GUARANTEE

A. Contractor shall guarantee all plants and planting in a healthy, thriving condition until the end of the Maintenance Period or until active growth is evident.

B. Replace all dead plants and plants not in a vigorous growing condition as soon as directed by the Owner or Landscape Architect. Plants used for replacement must be of the same kind and size as specified, planted and maintained as outlined above. All replacement of plants shall be at the sole expense of the Contractor.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Adjusting manholes, valves, monument covers and other structures to grade.

1.2 RELATED SECTIONS

A. Section 32 05 23 – Cement and Concrete for Exterior Civil Improvements

B. Section 32 12 00 – Flexible Paving

C. Section 32 13 00 – Rigid Paving

D. Section 33 05 16 – Utility Structures

1.3 DEFINITIONS

A. ASTM: American Society for Testing Materials.

1.4 SUBMITTALS

A. Follow submittal procedures outlined in Division 1.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 ADJUSTING MANHOLES, VALVES, MONUMENT COVERS AND OTHER STRUCTURES TO GRADE

A. Remove pavement, using vertical cuts, as needed to remove frame and provide for concrete collar. Do not damage adjacent pavement.

1. Circular Covers: Cut circle with radius 6 inches larger than cover and concentric with cover.
2. Rectangular Covers: Cut rectangle 6 inches larger than cover on all sides.

B. Install grade rings or blocking as needed to raise cover to finish grade.

C. Pour concrete collar:

1. Bottom of Collar: Top of existing collar or 6 inches below top of proposed collar, whichever is at a higher elevation.
2. Top of Collar: Bottom of existing asphalt pavement.
3. Apply tack coat to all exposed surfaces.

4. Fill excavation with asphaltic concrete and, while still hot, compact flush with adjacent surface.

3.2 INSTALLATION TOLERANCES

A. Adjust Covers:

1. Compacted surface: Up to 0.01 foot higher, and no lower, than adjacent pavement.

2. Do not create ponding.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manhole structures for gravity storm drain and sanitary sewer utilities.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.

B. Section 33 30 00 – Sanitary Sewerage Utilities.

C. Section 33 40 00 – Storm Drainage Utilities.

D. Section 32 05 23 – Cement and Concrete for Exterior Civil 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 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 01 33 00 – Submittal Procedures.

B. Product data for the following:

1. Cleanout plugs or caps.

C. Shop drawings: Include plans, elevations, details and attachments for the following:

1. Precast concrete manholes, frames and covers.
2. Precast concrete clean out boxes and box covers.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Handle precast concrete manholes according to manufacturer's written instructions.

B. Protect imported bedding and backfill material from contamination by other materials.

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 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 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 x D X 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 manufacturer's instructions.

5. Draw a vacuum of 10-inches of mercury and shut the pump off.

6. With the valve closed, the time for the vacuum to drop 9-inches shall be measured.

7. The manhole shall pass the test if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for a 60-inch diameter manhole and 90 seconds for a 72-inch diameter manhole.

8. If the manhole fails the initial test, make necessary repairs with a non-shrink grout while the vacuum is still being drawn. Retest until a satisfactory test is obtained.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Site water distribution system for domestic and fire protection services up to 5 feet of any on-site building being served.

B. Domestic water and fire protection water transmission or distribution system within a roadway or street right-of-way.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling

B. Section 32 05 23 – Cement and Concrete for Exterior Civil Improvements

1.3 RELATED DOCUMENTS

A. ASTM:

1. A 536: Specification for Ductile Iron Castings.
2. B 88: Specifications for Seamless Copper Water Tube.
3. D 1785: Specifications for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. D 2564: Specifications for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

B. 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. C115: Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. C150: Thickness Design of Ductile Iron Pipe.
7. C151: Ductile-Iron Pipe, Centrifugally Cast, for Water.
8. C153: Ductile- Iron Compact Fittings for Water Service.
9. C200: Steel Water Pipe-6 In. (150 mm) and larger.
10. C203: Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.

11. C205: Cement-Mortar Protective Lining and Coating for Steel Water Pipe- 4 In. and Larger-Shop Applied.
12. C207: Steel Pipe Flanges for Waterworks Service-Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
13. C208: Dimensions for Fabricated Steel Water Pipe Fittings.
14. C209: Cold Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
15. C210: Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
16. C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
17. C214: Tape Coating Systems for the Exterior of Steel Water Pipelines.
18. C218: Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.
19. C219: Bolted, Sleeve-type Couplings for Plain-End Pipe.
20. C500: Metal-Seated Gate Valves for Water Supply Service.
21. C502: Dry-Barrel Fire Hydrants.
22. C503: Wet Barrel Fire Hydrants.
23. C504: Rubber Seated Butterfly Valves.
24. C507: Ball Valves 6 In. Through 8 In. (150 mm Through 1,200 mm).
25. C508: Swing-check Valves for Waterworks Service, 2 In. (50mm) Through 24 In. (600 mm) NPS.
26. C509: Resilient-Seated Gate Valves for Water Supply Service.
27. C510: Double Check Valve Backflow-Prevention Assembly.
28. C511: Reduced-Pressure Principle Backflow-Prevention Assembly.
29. C512: Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
30. C550: Protective Epoxy Interior Coatings for Valves and Hydrants.
31. C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.
32. C605: Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings.
33. C606: Grooved and Shouldered Joints.
34. C651: Disinfecting Water Mains.
35. C800: Underground Service Line Valves and Fittings.

36. C900: Polyvinyl Chloride (PVC) Pressure Pipe and Fittings, 4 In. Through 12 In. (100mm Through 300mm) for Water Distribution.
37. C901: Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13mm) Through 3 In. (76mm) for Water Service.
38. C905: Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm) for Water Transmission and Distribution.
39. C906: Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) through 63 In (1,575 mm), for Water Distribution and Transmission.
40. C907: Polyvinyl Chloride (PVC) Pressure Fittings for Water – 4 In. through 8 In. (100 mm Through 200 mm).
41. C908: PVC Self-Tapping Saddle Tees for Use on PVC Pipe.
42. M11: Steel Pipe - A Guide for Design and Installation.
43. M23: PVC Pipe – Design and Installation.
44. M41: Ductile-Iron Pipe and Fittings.

1.4 DEFIN1TIONS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ASTM: American Society for Testing Materials.

C. AWWA: American Waterworks Association

D. DI: Ductile iron.

E. DIP: Ductile iron pipe.

F. FM: Factory Mutual.

G. NFPA: National Fire Protection Association.

H. NSF: National Sanitation Foundation.

I. PCC: Portland cement concrete.

J. PE: Polyethylene.

K. PVC: Polyvinyl Chloride.

L. UL: Underwriters Laboratory.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Internal Pressures: As indicated on plans.

B. External Load: Earth load indicated by depth of cover plus AASHTO H20 live load unless indicated otherwise.

1.6 SUBMITTALS

A. Follow submittal procedures outlined in Division 1.

B. Product Data: For the following:

1. Piping materials and fittings.
2. Pipe couplings.
3. Flexible pipe fittings.
4. Restrained pipe fittings.
5. High deflection fittings/ball joints.
6. Expansion joints.
7. Flexible expansion joints.
8. Gate valves.
9. Butterfly valves.
10. Check valves.
11. Air and vacuum relief valves.
12. Blow-off valves.
13. Pressure reducing valves.
14. Pressure sustaining valves.
15. Ball valves.
16. Fire hydrants.
17. Post indicator valves.
18. Fire department connections.
19. Backflow preventers.
20. Precast valve boxes and box covers.

C. Shop drawings: Include plans, elevations, details and attachments.

1. Precast and cast in-place vaults and covers.
2. Wiring diagrams for alarm devices.

D. Field test reports: Indicate and interpret test results for compliance with the Project requirements.

1.7 QUALITY ASSURANCE

A. Comply with requirements of utility supplying water. Do not operate existing valves or tap existing piping without written permission and/or presence of utility company representative.

B. Comply with the following requirements and standards:

1. NSF 61: “Drinking Water System Components-Health Effects” for materials for potable water.

2. NFPA 24: “Installation of Private Fire Service Mains and Their Appurtenances” for materials, installations, tests, flushing, and valve and hydrant supervision.

3. NFPA 70: “National Electric Code” for electrical connections between wiring and electrically operated devices.

C. Provide listing/approval stamp, label, or other marking on piping and specialties made to a specified standard.

1.8 MATERIAL DELIVERY, STORAGE AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.

3. Set Valves in best position for handling. Set valves closed to prevent rattling.

B. Deliver piping with factory-applied end-caps. Maintain end-caps through shipping, storage and handling to prevent pipe end damage and to prevent entrance of dirt, debris and moisture.

C. Handling: Use slings to handle valves and fire hydrants whose size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. During Storage: Use precautions for valves, including fire hydrants according to the following.

1. Do not remove end protectors, unless necessary for inspection, then reinstall for storage.

2. Protection from Weather: Store indoors and maintain temperature higher than ambient dew-point temperature. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

E. Do not store plastic pipe and fittings in direct sunlight.

F. Protect pipe, fittings, flanges, seals and specialties from moisture, dirt and damage.

G. Protect linings and coatings from damage.

H. Handle precast boxes, vaults and other precast structures according to manufacturer's written instructions.

I. Protect imported bedding and backfill material from contamination by other materials.

1.9 COORDINATION

A. Coordinate connection to existing water mains with water utility supplying water.

B. Coordinate piping materials, sizes, entry locations, and pressure requirements with building domestic water distribution piping and fire protection piping.

PART 2 PRODUCTS

2.1 SMALL-SIZE SERVICE PIPES

A. Copper Pipe: Sizes ¾-inch through 2-inch.

1. Pipe and Fittings: ASTM B 88, Type K, seamless water tube, annealed.

2. Joints: Restrain by couplings.

B. PVC Pipe: Sizes1/8-inch through 3 inch.

1. Pipe and Fittings: ASTM D 1785, Schedule 40

2. Joints: Restrain with solvent cement. Do not use threaded pipe.

3. Solvent Cement: ASTM D2564.

2.2 LARGE-SIZE SERVICE AND DISTRIBUTION PIPES

A. DIP: Sizes 4-inch through 48-inch.

1. Pipe: AWWA C150 and C151 (Specify Thickness Class 50, 51, 52, 53…).

2. Fittings

a. Standard: AWWA C110, sizes 4-inch through 48-inch.

b. Compact: AWWA C153, sizes 4-inch through 24-inch.

3. Pipe and Fitting Lining: Cement Mortar, AWWA C104.

4. Pipe and Fitting Coating: Asphaltic, AWWA C151 or C115.

5. Exterior Soil Corrosion Protection for Pipe and Fittings: Polyethylene encasement, AWWA C105.

6. Restrained Joints:

a. Flanged Joint: AWWA C115.

b. Push-On Bell and Spigot Joint: AWWA C111 with “Field Lok Gasket,” sizes 4-inch through 24-inch;“TR Flex,” sizes 4-inch through 64-inch; both by U. S. Pipe (Birmingham AL) (Tel.205-254-7442) or approved equal. “Megalug” restraint harness, Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

c. Mechanical Joint: AWWA C111 with “Mega Lug,” sizes 3-inch through 48-inch. Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

7. Couplings:

a. Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.

b. Plain End Pipe to Flanged Pipe: 1) Ductile iron or steel bolted flanged coupling adapters, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel flanged couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal; or 2) restrained flange adapter, “Megaflange,” sizes 3-inch through 36 inch, Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

B. PVC Pipe: Sizes 4-inch through 48-inch (Specify Pressure Class 305(200psi), 235 (150psi)).

1. Pipe:

a. 4-inch through 12-inch: AWWA C900.

b. 14-inch through 48-inch: AWWA C905.

2. Fittings: DI conforming to 2.02.A.2 above.

3. Restrained Joints:

a. Push-On Bell and Spigot Joint: Harness assembly as manufactured by Ebaa Iron (Eastland, Tx) (Tel. 800-433-1716) or approved equal.

b. Mechanical Joint: AWWA C111 with “Mega Lug,” sizes 3-inch through 48-inch. Ebaa Iron (Eastland TX) (Tel 800-443-1716) or approved equal.

4. Steel or Ductile Iron Couplings:

a. Plain End Pipe to Plain End Pipe: Ductile iron or steel bolted couplings, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.

b. Plain End Pipe to DI or Steel Flanged Pipe: Ductile iron or steel bolted flanged coupling adapters, manufacturer’s shop coating with low alloy steel bolts and nuts. Steel flanged couplings to conform to AWWA C219. Smith-Blair, Inc, (Texarkana, AR) (Tel. 501-773-5127), Dresser (Bradford, PA) (Tel.-814-368-3131) or approved equal.

5. PVC Couplings

a. Unrestrained Plain End to Plain End Pipe: AWWA C900, as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.

b. Restrained Plain End to Plain End Pipe: AWWA C900, “Certa-Lock” as manufactured by CertainTeed (Valley Forge, PA) (Tel. 610 341-6820) or approved equal.

2.3 GATE VALVES

A. Provide on lines 10-inch and smaller.

B. Valves, 3-Inch through 20-Inch: AWWA C509, resilient-seated, non-rising stem, gray or ductile-iron body and bonnet, with bronze or gray or ductile-iron gate, bronze stem and square stem operating nut unless noted otherwise. All bolts, nuts and washers, except operating nut, shall be stainless steel. Stem operating nut to be 2-inches square and open counter-clockwise. Stem extensions shall be installed to bring the stem operating nut to within 2-feet of finish grade where the depth from finish grade to the stem operating nut exceeds 4-feet. Equip valves in pump stations and other interior or vault installations with hand-wheels. Provide protective epoxy interior and exterior coating according to AWWA C550 and manufacturer’s recommendations.

C. Service Line Valves and Fittings, 2-Inch and Smaller: AWWA C800

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Company (Decatur, IL) (Tel.800-423-1323).
2. M&H Valve Company (Anniston, AL) (Tel. 205-237-3521).
3. Crane Company (New York, NY).

E. Valve Box and Cover: 9-inch minimum diameter PCC box with extensions of length required for depth of bury of valve, and cast iron or ductile iron cover with lettering “WATER”. Both the box and the cover shall be rated for AASHTO H20 loading.

2.4 SWING CHECK VALVES

A. Valves 2-Inch through 24-Inch: AWWA C508, details as indicated.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Company (Decatur, IL) (Tel.800-423-1323).
2. M&H Valve Company (Anniston, AL) (Tel. 205-237-3521).

2.5 SERVICE CONNECTIONS AND WATER METERS

A. Service connections and water meter details and boxes as indicated.

2.6 FIRE HYDRANTS

A. Wet Barrel: AWWA C503, details as indicated.

B. Dry Barrel: AWWA C502, details as indicated.

2.7 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER

A. Provide as indicated and as required by State or local agency.

B. General: AWWA C511, with OS gate valve on inlet and outlet, and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air gap fitting located between 2 positive-seating check valves for continuous-pressure application.

C. Body:

1. 2-Inch and Smaller: Bronze with threaded ends.

2. 2-1/2-Inch and Larger: Bronze, cast iron steel, or stainless steel with flanged ends.

D. Interior Lining: AWWA C550, epoxy coating for cast iron or steel bodies.

E. Interior Components: Corrosion-resistant materials.

F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).

2. Ames Company (Woodland, CA) (Tel. 916-666-2493).

3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).

4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.8 DOUBLE CHECK DETECTOR ASSEMBLY

A. FM approved or UL listed, with OS&Y gate valve on inlet and outlet, and strainer on inlet. Include two positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and double-check backflow preventer, for continuous pressure application.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Cla-Val Company (Newport Beach, CA) (Tel. 714-548-2201).

2. Ames Company (Woodland, CA) (Tel. 916-666-2493).
3. Febco, CMB Industries, Inc. (Fresno, CA) (Tel. 559-252-0791).
4. Hersey Products, Inc. (Dedham, MA) (Tel. 617-326-9400).

2.9 POST INDICATOR VALVE

A. General: UL 789, FM approved, vertical-type, cast-iron body with operating wrench extension rod, and adjustable cast-iron barrel of length required for depth of bury of valve. Review fire department connection with agency having jurisdiction. Check hose threads and all sizes with fire department.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. Mueller Co. (Decatur, IL) (Tel.800-423-1323).
2. Clow Corporation (Oskaloosa, IA).

2.10 FIRE DEPARTMENT CONNECTION

A. Exposed, Freestanding Fire Department Connection: UL 405, cast brass body with threaded inlets according to NFPA 1963 and matching local fire department hose threads and threaded bottom outlet. Include lugged caps, gaskets and chains; lugged swivel connections and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate. Four 2-1/2-inch NPS inlets and 6-inch NPS outlet.

2.11 UNDERGROUND VAULTS/PITS

A. General: Portland cement concrete, precast or cast-in-place as indicated.

B. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Cement and Concrete for Exterior Improvements.

C. Access Openings: As indicated.

D. External Load: Earth load plus AASHTO H20 live load if located in traffic area.

2.12 TRACER WIRE

A. General: Minimum #12 AWG stranded copper wire with blue THW, THWN, or THHN rated insulation.

2.13 WARNING TAPE

A. General: Non-detectable 3-inch warning tape made of solid blue film with continuously printed black-letter message reading “CAUTION—WATER LINE BURIED BELOW.”

2.14 PCC THRUST BLOCKS

A. Portland Cement Concrete and Reinforcing Steel: Section 32 05 23 – Concrete for Civil Improvements.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with the following:

1. DIP: AWWA M41 and AWWAC600.
2. PVC pipe: AWWA M23 and AWWA C605.
3. Steel Pipe: AWWA M11.

B. Pipe Depth and Trench Configuration: Conform to elevations, profiles and typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer's recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Lay pipe on a bed of bedding material specified and prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout 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. If necessary, use shorter than the standard lengths of pipe to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

G. Closure: Close open ends of pipes and appurtenance openings at the end of each days work or when work is not in progress.

3.2 CONNECTING TO EXISTING MAINS

A. Pressure Tap Connections: Perform in accordance with the requirements of the owner of the system being tapped. Maintain a positive pressure flow from the main being tapped to the tapping device to flush plastic chips, metal ribbons, etc. into the tapping devise and not into the pipe being tapped.

B. Other Connections: As indicated and in accordance with the requirements of the owner of the line being connected to.

3.3 ANCHORAGE INSTALLATION

A. Mechanically Restrained Joints: Install where indicated for lengths indicated in accordance with manufacturer's instructions.

B. PCC Thrust Blocks: Install where required and as indicated. Bearing area indicated is to be against undisturbed earth. Allow a minimum of 24-hours curing time before introducing water into the pipeline and allow a minimum of 7-days curing time before pressure testing.

3.4 VALVE INSTALLATION

A. Install all valves in accordance with the manufacturer's instructions and the following:

1. General:

a. Gate Valves: Appendix A of AWWA C509.

b. Butterfly Valves: Appendix A of AWWA C504.

2. Joints:

a. Valves on DI, PE and PVC Pipe: Mechanical joint valves for buried locations. Flanged-end valves for installation in vaults/pits.

b. Valves on Steel Pipe: As indicated for buried locations. Flanged-end valves for installation in vaults/pits.

3.5 SERVICE CONNECTIONS INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system.

3.6 WATER METER INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system.

3.7 FIRE HYDRANT INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.8 REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTER INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the local health department requirements.

3.9 DOUBLE CHECK DETECTOR ASSEMBLY INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.10 POST INDICATOR VALVE INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install as indicated and in accordance with the requirements of the owner of the system and the fire department.

3.12 UNDERGROUND VAULT/PIT INSTALLATION

A. Install as indicated.

B. Excavation and Backfill: Section 31 23 33 – Trenching and Backfilling.

3.13 TRACER WIRE INSTALLATION

A. Install on trench bottom under the vertical projection of the pipe to protect it in all installations.

B. Form a mechanically and electrically continuous line throughout the pipeline, extending to the nearest valve or other pipeline appurtenance designated by the owner of the system or the Owner. Extend the wire up the outside of the valve box/riser and cut a hole that is 8-inches from the top, extend a 12-inch wire lead to the inside of the box. At other pipeline appurtenances, designated by the owner of the system or the Owner, terminate the 12-inch wire lead inside the enclosure.

C. Splice wire with a splicing device consisting of and electro-tin plated seamless copper sleeve conductor. Install as recommended by the manufacturer. Wrap splices and damaged insulation with electrician's tape.

3.14 WARNING TAPE INSTALLATION

A. Install tape approximately 1-foot above and along the centerline of the pipe.

B. Where tape is not continuous, lap tape ends a minimum of 2-feet.

3.15 HYDROSTATIC PRESSURE AND LEAKAGE TEST

A. General:

1. Provide all necessary materials and equipment, including water.
2. Backfill all trenches sufficient to hold pipe firmly in position.
3. Allow time for thrust blocks to cure prior to testing.
4. Flush all pipes prior to testing to remove all foreign material.
5. Perform pressure and leakage test concurrently.
6. Test pressure: See Subsection titled “System Performance Requirements.”
7. Apply test pressure by means of a pump connected to the pipe.
8. Base test pressure on the elevation of the lowest point in the line.
9. Fill each closed valve section or bulk-headed section slowly. Expel air from section being tested by means of permanent air vents installed at high points or by means of temporary corporation cocks installed at such points. Remove and plug the temporary corporation cocks at the conclusion of the test.
10. Allow water to stand in the pipe for 24 hours before test pressure is applied.
11. Allow the system to stabilize at the test pressure before conducting the leakage test.
12. Do not operate valves in either the opening or closing direction at differential pressures above the valves rated pressure.
13. Maintain test pressure as specified for type of pipe being tested.
14. Pressure Test: Examine any exposed pipe, fittings, valves, hydrants and joints during the test, if no leaks are observed the section of line has passed the pressure test. If leaks are observed, repair any damaged or defective pipe, fittings, valves, or hydrants, and repeat the pressure test.
15. Leakage Test: Perform as specified hereafter for the type of pipe being installed.

B. DIP Leakage Test: Perform in accordance with AWWA C600. Selected requirements of AWWA C600 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.
2. No piping will be accepted if the leakage is greater than that determined by the following formula:
3. $L = (S \times D \times P^{1/2})/133{,}200$
4. L = Allowable leakage, gallons per hour.
5. S = Length of pipe tested, feet.
6. D = Nominal diameter of pipe, inches.

7. P = Average test pressure during the leakage test, pounds per square inch (gauge).

C. PE Pipe Leakage Test:

1. Apply the test pressure and allow the pipe to stand, without makeup pressure, for sufficient time to allow for diametric expansion or pipe stretching to stabilize, approximately two to three hours.

2. After the above stabilization has occurred, return the section being tested to the test pressure. Hold the test pressure for one to three hours. If the pressure in the test section drops, and it is determined the drop may be the result of expansion resulting from increasing temperature, a limited amount of additional water may be added to bring the pressure back to the test pressure. Allowable amounts of make-up water, to compensate for expansion due to increasing temperature, are as shown in the following table. Make-up water is only allowed during this final test period and not during the initial stabilization described in the previous paragraph. If the additional water added is less than the allowable shown in the table and there are no visual leaks or significant pressure drops, the tested section passes the test.

Nominal Pipe Size (in.)	Allowance for Expansion (U.S. Gals./100 Feet of Pipe)		
	1-Hour Test	2-Hour Test	3-Hour
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.50
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	8.9	13.3
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0

D. PVC Pipe Leakage Test: Perform in accordance with AWWA M23. Selected requirements of AWWA M23 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.

2. No piping will be accepted if the leakage is greater than that determined by the following formula:

$L = (N \times D \times P^{1/2})/7{,}400$

L = Allowable leakage, gallons per hour.

N = Number of joints in the length of the pipeline tested.

D = Nominal diameter of pipe, inches.

P = Average test pressure during the leakage test, pounds per square inch (gauge).

E. Cement Mortar Lined and Coated Steel Pipe Leakage Test: Perform in accordance with AWWA M11. Selected requirements of AWWA M11 are repeated as follows:

1. Maintain the test pressure, +/- 5 psi, for a minimum of two hours.

2. There shall be no significant leakage for pipe with welded joints or mechanical couplings.

3. For pipe joined with O-ring rubber gaskets, a leakage of 25 gallons per inch of diameter per mile per 24-hours is allowed.

3.16 DISINFECTION

A. All New Pipelines shall be disinfected in accordance with one of the three methods specified in AWWA C651 and the following:

1. Disinfect after pressure and leakage test have been performed and accepted.

2. The method used shall be at the Contractor's option, unless specified by the owner of the water system.

3. Engage the services of a commercial testing laboratory, approved by the owner of the water system, to perform the bacteriological tests specified in Section 5.1 of AWWA C651. Direct the testing laboratory to send the original report of the bacteriological testing to the owner of the water system. Should the laboratory report show that any sample taken was not acceptable, repeat the sterilization process shall until a satisfactory sterilization is accomplished.

4. Lawfully dispose of the chlorinated water.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roadway and/or site sanitary gravity sewers and force mains up to 5 feet of any on-site building.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling

B. Section 32 05 23 – Cement and Concrete for Exterior Civil Improvements.

C. Section 33 05 16 – Utility Structures.

1.3 RELATED DOCUMENTS

A. AASHTO:

1. M 252: Corrugated Polyethylene Drainage Tubing.
2. M 294: Corrugated Polyethylene Pipe, 12 to 24-inch Diameter.

B. ASTM:

1. A 615/A615M: Deformed and Billet-Steel Bars for Concrete Reinforcement.
2. A 674 Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids.
3. C 443: Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
4. C 1173: Flexible Transition Couplings for Underground Piping Systems.
5. D 1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
6. D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
7. D 2321: Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
8. D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
9. D 2751: Acrylontrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
10. D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
11. D 4101: Propylene Injection and Extrusion Materials.
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 679: Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

15. 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

1.4 DEFINITIONS

A. AASHTO: American Association of State Highway and Transportation Officials.

B. ABS: Acylonitrile-butadiene-styrene.

C. ASTM: American Society for Testing Materials.

D. AWWA: American Water Works Association.

E. HDPE: High-density polyethylene.

F. PE: Polyethylene.

G. DIP: Ductile iron pipe.

H. PVC: Polyvinyl Chloride.

I. RCP: Reinforced concrete pipe.

J. NPS: Nominal pipe size.

1.5 SUBMITTALS

A. Follow submittal procedures outlined in Division 1.

B. Product data for the following:

1. Piping materials and fittings.
2. Special pipe couplings.
3. Joint sealants.
4. Sewage air relief valves.

C. Shop drawings: Include plans, elevations, details and attachments for the following:

1. Force main piping access openings.

D. Design Mix Reports and Calculations: For each class of cast-in-place concrete.

E. Field Test Reports: Indicate and interpret test results for compliance with performance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight.

B. Protect pipe, fittings, and seals from dirt and damage.

C. Handle precast concrete pipe and other precast structures according to manufacturer's written instructions.

D. Protect imported bedding and backfill material from contamination by other materials.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS FOR GRAVITY FLOW

A. PVC Pipe:

1. Pipe:
   a. 4-inch through 15-inch: ASTM D 3034, SDR 26. Bell and spigot joints.
   b. 18 inch through 36-inch: ASTM F 679, T-1 wall. Bell and spigot joints.
2. Fittings:
   a. 4-inch through 27-inch: ASTM F 1336.
   b. 30-inch through 36-inch: ASTM D 3034, SDR 26
3. Joint Gasket: Elastomeric seal, ASTM F 477.

2.2 SPECIAL PIPE COUPLINGS

A. Gravity Piping: ASTM C 1173. Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined.

2.3 MANHOLES AND CLEANOUTS

A. See Section 33 05 16 – Utility Structures.

PART 3 - EXECUTION

3.1 GRAVITY PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe and chapter 11.3.3 of AWWA M41 for ductile iron pipe.

B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with the manufacturer's recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout its entire length with bell holes provided at the ends of each pipe length of sufficient size to permit making up the particular type of joint being used. Adjust pipe to line and grade by scraping away or filling and tamping material under the body of the pipe for the entire pipe length and not by blocking or wedging. After final positioning, hold pipe in place in trench with backfill material placed equally on both sides of the pipe at as many locations as required to hold the pipe section in place.

F. Curved Alignment: When necessary to conform to the alignment specifically indicated, lay pipe on a curved alignment by means of asymmetrical closure of joints or bending of the pipe barrel. Use shorter lengths of pipe than the standard length if necessary to achieve curvature specified. Do not exceed the recommendations of the pipe manufacture for deflections at the joints or pipe bending.

G. Closure: Close open ends of pipes and appurtenance at the end of each days work or when work is not in progress.

3.2 SPECIAL PIPE COUPLINGS

A. General: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

B. Installation: Per manufacturer's instructions.

3.3 TESTING OF GRAVITY PIPING MAINS

A. Obstructions: After backfilling and compacting, but before paving or other surface improvements, test sewer for obstructions either by rodding or by the sewer ball method. Provide for intercepting all grit, rocks and other flushed debris to keep debris from entering the existing system.

B. At the option of the Contractor, either the following hydrostatic or air test shall be performed.

C. Hydrostatic Test:

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
2. Test sewer mains between successive manholes by closing the lower end of the sewer main to be tested and the inlet sewer main of the upper manhole with stoppers.
3. Fill pipe and manholes with water to a point four feet below the ground surface of the upper manhole, but in no case less than four feet above the pipe invert. If ground water is present, the water surface at the upper manhole shall be at least four feet above the level of the ground water.
4. Fill piping at least one hour prior to testing.
5. Test piping at least two hours by maintaining the head specified above with measured additions of water. The sum of these additions of water, in the two-hour test period, shall be the leakage amount.
6. The maximum allowable head of water above any porti9n of sewer being tested shall be 15-feet. Where the difference in elevation between successive manholes exceeds 15-feet, a test tee shall be installed between manholes, and the testing shall be carried on between the tee and the manhole.
7. The allowable leakage shall not exceed 0.1-gallons per minute per inch diameter, per 1000-feet of sewer main being tested.
8. If the leakage exceeds the above amount, determine the cause and remedy it prior to retesting.
9. If the leakage is less than the allowable, but leaks are observed, repair the observed leaks.

D. Air Test:

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
2. Apply to each length between adjacent manholes.
3. Supply pressure gauge with minimum divisions of 0.10-psi and with an accuracy of +/- 0.04-psi. When requested by the Owner, provide certification that the gauge has been tested for accuracy within the last six months by a reliable testing firm.

4. Pressurize the test section to 3.5-psi, and then hold the pressure above 3.0-psi during a saturation period of at least 5 minutes. At the end of the saturation period, note the pressure, which must be a minimum of 3.0-psi, and begin the timed period. If the pressure drops 0.5-psi in less than the time given in the following table the section of pipe has not passed the test.

Pipe Size	Minimum Time Allowed for Pressure to Drop 0.5-PSI
4”	125 seconds
6”	185 seconds
8”	245 seconds
10”	310 seconds
12”	370 seconds
15”	460 seconds
18”	555 seconds
21”	10 minutes
24”	12 minutes
27”	14 minutes
30”	16 minutes
36”	18 minutes
42”	20 minutes
48”	23 minutes
54”	26 minutes

5. If the time for the pressure to drop 0.5-psi is 125% or less of the time indicated, the line shall immediately be re-pressurized to 3.0-psi and the test repeated. If, during the 5-minute saturation period, the pressure drops less than 0.5-psi after the initial pressurization and air is not added, the section undergoing the test shall have passed.

6. If the test did not pass, find and repair the leak to the satisfaction of the Owner.

7. When the prevailing ground water is above the line being tested the air pressure shall be increased 0.43-psi for each foot the water table is above the invert of the pipe at the highest manhole.

3.4 TESTING OF LATERALS

A. At the option of the Contractor, either the following hydrostatic or air test shall be performed.

B. Hydrostatic Test:

1. Test laterals before backfilling.

2. Plug lateral at its ends and fill with water through the cleanouts.

3. Maintain the water level in the cleanouts as high as possible throughout the test period.

4. One hour after filling with water, examine the lateral for leakage.

5. Repair all leaks to the satisfaction of the Owner.
6. Do not backfill the trench until testing and repairs of the lateral are complete, and approved by the Owner.
7. Following approval of the Owner, remove all plugs, dispose of the water and complete the connection to the main.

C. Air Test

1. Test after backfilling to finish grade or pavement structural section subgrade in paved areas.
2. Test in accordance with subsection above titled “Testing of Gravity Piping Mains,” paragraph titled “Air Test.”

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Roadway and/or site storm drainage up to 5-feet of any on-site building.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling

B. Section 32 05 23 – Cement and Concrete for Exterior Civil Improvements

C. Section 33 46 00 – 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: Acrylontrile-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: Acylonitrile-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 32 05 23 – 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 32 05 23 – 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).

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 33 05 16 – Utility Structures.

2.5 POLYMER-CONCRETE TRENCH DRAINS

A. General: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include number of units required to form total length required.

B. Include the following components:

1. Channel Sections: Interlocking-joint, precast modular units with end caps. Inside width as indicated with deep, rounded bottom, with built in slope or flat invert as indicated and outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.

2. Frame and Grate: Gray iron, ductile iron or galvanized steel as indicated. Where drain is located in traffic areas, rate for AASHTO H20 loading.

C. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Project include, but are not limited to, the following:

1. "Polydrain" by ABT Inc. (Troutman, NC) (Tel 704-528-9806).

2. "ACO Drain" by ACO Polymer Products Inc. (Chardon, OH) (Tel. 800-543-4764).

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, fittings, and appurtenances utilizing best practices, manufacturer's instructions, and in accordance with Section 6 and 7 of ASTM D 2321 for plastic pipe, Caltrans Standard Specification Section 65-1.07 for reinforced concrete pipe, Caltrans Standard Specification Sections 66-1.045 and 66-105 for corrugated metal pipe and chapter 11.3.3 of AWWA M41 for cast iron and ductile iron pipe.

B. Pipe Depth and Trench Configuration: Conform to typical trench section(s) indicated.

C. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

D. Handling: Carefully handle during loading, hauling, unloading and placing operations to avoid breakage or damage. Use strap type slings for lifting and placing; no chains or hooks will be permitted. Comply with manufacturer's recommendations.

E. Laying: Before lowering pipe into the trench, remove all stakes, debris, loose rock and other hard materials from the bottom of the trench. Lay accurately in conformance with lines and grades indicated. Start laying the pipeline at the low end and proceed upstream. Lay bell and spigot pipe with the bell end facing upstream. Lay pipe on a bed prepared by handwork, dug true to grade. Furnish firm bearing for pipe throughout 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 31 23 33 – Trenching and Backfilling.

B. Poured in Place Structures: Install as indicated and Caltrans Standard Specification Section 51.

1. Shape bottoms to convey flows as indicated.

C. Precast Structures: Install as indicated.

1. Seal all joints and pipe entrances and exits.

2. Place concrete in bottom and shape to convey flows as indicated.

3.5 POLYMER-CONCRETE TRENCH DRAIN INSTALLATION

A. Excavation, Bedding, Backfill, and Compaction: Section 31 23 33 – Trenching and Backfilling.

B. Install: As indicated and in accordance with the manufacturer's instructions.

3.6 CONCRETE OR PLASTIC FLARED END SECTION INSTALLATION

A. Install: As indicated.

3.7 TESTING

A. Do not enclose, cover, or put into service before inspection and approval.

B. Test completed piping systems according to authorities having jurisdiction.

C. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.

D. Submit separate reports for each test.

E. 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.

F. Leaks and loss in test pressure constitute defects that must be repaired.

G. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Subdrains in trenches and subdrains or prefabricated composite drainage panels at walls or foundations.

B. Sand-Swale filters in parking lot areas.

1.2 RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling

B. Section 33 05 16 – Utility Structures

C. Section 33 40 00 – Storm Drainage Utilities

1.3 RELATED DOCUMENTS

A. AASHTO:

1. M 252: Corrugated Polyethylene Drainage Tubing.
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: Acrylontrile-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: Acylonitrile-Butadiene-Styrene.

C. AWWA: American Water Works Association.

D. ABS: Acylonitrile-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 33 05 16 – 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.

1. 100 percent passing 1-inch sieve

2. 82 percent passing ¾-inch sieve

3. 2 percent passing ½-inch sieve

4. 1 percent passing 3/8-inch seive

B. 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 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 31 23 33 – Trenching and Backfilling, and Section 33 46 00 – Storm Drainage Utilities.

3.5 PREFABRICATED COMPOSITE DRAINAGE PANELS

A. Coordinate placement with other drainage materials.

B. Install prefabricated drainage panels in accordance with manufacturer’s instructions.

C. Place perforated drainage pipe at base of footing and attach to composite drainage panels in accordance with the manufacturer's instructions.

3.6 JOINING PIPE

A. Join ABS and PVC pipe and fittings with elastomeric seals according to ASTM D 2321 or solvent cement.

B. Special pipe couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and that fit both pipe materials and dimensions.

3.7 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION