

TECHNICAL SPECIFICATIONS

GREENHOUSE

AT

FULLERTON COLLEGE

321 E. Chapman Avenue
Fullerton, CA 92832

NORTH ORANGE COUNTY COMMUNITY COLLEGE DISTRICT

1830 Romneya Drive
Anaheim, CA 92801-1819
Tel. (714) 808-4500



WW Project No. 18041.00

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WESTBERGWHITE, Inc.

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Summary of Greenhouse Building Requirements

To be included in Package:

- Structure:
 - 1 range of 2 Solar Lights 30' x 60' x 12' meets IBC 12/100C
 - 12 lb live load / 100mph wind load
 - 2) Independent growing zones
 - 4) Hinged doors (3' 6" W x 6'8" H) Vestibules
 - 3) Hinged doors (3' W x 6'8" H) one LEAN-TO access
 - Steel base angle to connect wall glazing to concrete floor areas
 - 2) Pressurized vestibule entrances 18' W x 12' L x 12' Eave
 - Covered with 8mm Twinwall Polycarbonate (PC8) opal
 - 2) Positive pressure fans 24", 3/4 hp (1 per vestibule)
 - Positive pressure doors
- Roof Vent:
 - 2) Roof vents (APPROXIMATELY) 54"W x 60'L ea
 - 2) Ridder RW 45 gearmotors 115v, 1ph, 1/8 hp
 - Microgrow Ventmate Plus system
- Covering:
 - Roof & Exterior Walls:
 - 2) Vestibules: PC8 Amerilux Verolite Opal (40% - light transmission)
 - 1) Interior wall partition: pc-8
- Heating/Air-circulation:
 - Unit Heaters - Modine PTP Series:
 - 2) PTP 175 SS 115v, 1ph, 1/6 hp (1 per house)
 - Includes heater mounts | Flue kits provided by others
 - Air circulation – ACME Horizontal Air Flow Fans:
 - 4) 20" ACME HAF fans 115v, 1ph, 1/15th hp (2 per house)
- Evaporative Cooling System:
 - 4) Acme DC 42" exhaust fans 208v, 3ph, 1 hp
 - Includes steel mounts and trims
 - 2) CSEG 6" x 4' x 30' distribution systems
 - Includes valves, pumps and mounts
 - 2) Pad Vents 4' x 30'
 - 2) Ridder RW 45 gearmotors 115v, 1ph, 1/8 hp

- 2) Endwall lean-to structures 60' length covered with insect screen – 50 mesh
 - stemwall at base of lean-to to seal screen at grade
- Energy Curtain System (Independent for each greenhouse):
 - 2) Energy curtain systems – slope-flat-slope
 - 2) Ridder RW45 gearmotors 115v, 1 ph, 1/8 hp
 - Curtain Fabric: Ludvig Svensson – Harmony 4647 (46% shade 47% energy savings)
- Nutrient Delivery System:
 - Dosatron
- MICROGROW Control System:
 - Water Pro VPD – irrigation and propagation control
- MICROGROW Growlink:
 - Growlink – Controls entire greenhouse zones from PC, also provides ability to remotely control and monitor
 - Wifi enabled sensors for Data Collection
- Misting System:
 - Automated PVC mist distribution system with timer controls, solenoid valve, and misting nozzles to cover each zone
- Amhydro NFT 288 Bundle:
 - 2) Bundles (includes)
 - Complete grow system
 - Growing Supplies
 - Propagation System
- Grow Lights:
 - High pressure sodium fixtures
- Metal Stationary Work Tables:
- Metal Rolling Benches:

Solar Light range of two 30 x 60 x 14

This structure is to be engineered to meet the International Building Code requirements of 12 lbs/ft² roof live load [Per IBC-12 Sec 1607.11.2.1 Greenhouse] and 100 mph exposure C wind load for agriculture occupancy use (group "U", Risk category 1). Wet signed calculations and drawings to be provided by an independent licensed engineer.

Solar Light:

- Pre-drilled galvanized steel columns
- Gable style bolt together trusses with 6:12 pitch condensation control system
 - Top chord galvanized break-formed steel with condensate gathering 'V' channel
 - Webs and bottom chord galvanized structural grade steel
- Specialized break-formed "Z" design condensate gathering purlins
- Break formed gable girts and wall girts.
- Pre-punched gutters 11" wide x 6" deep (3.5 gallons/linear foot capacity)
- Steel tube bracing

Standard Engineering Package:

- Engineering services provided by an independent licensed engineer
- Site-specific wet signed calculations and drawings
- Structure subject to upgrade costs based on final engineering

OTHER COMPONENTS-

Hinged Door:

- Completely assembled pre-hung with three 4-way universal swing steel hinges
- Ready to install with jambs, headers, lock sets, weather stripping and trim package
- R12 insulation value with a weather tight seal
- Frame jamb, header and sill are white with baked polyester coating
- ADA handicap compliant

Vestibule:

- Vestibule area to prepare for clean entry and exit to and from the greenhouse
- Sanitation and insect exclusion

Lean-To:

- Insect exclusion structure for protecting air inlets/outlets
- Designed around the CFM requirements of cooling system
- Roof typically covered with rigid glazing or screen
- Walls typically covered with screen

- 16 Gauge top chords attach Lean-To to greenhouse

Roof Vents:

- Double vent at peak promoting temperature control, humidity control, CO₂/oxygen replacement and air circulation
- Consists of heavy duty steel racks with pinions 6' on center with an extra rack at each vent end for added wind support.
- Arched racks prevent integration issues with interior equipment or curtain systems
- All extrusions shall be heavy duty, low maintenance & the best weather seal possible
- Include 1 3/8" Dia. tubing shaft, fasteners and closure stripping

8mm Twinwall Polycarbonate diffused & opal

- 10 x stronger than acrylic & 200 x stronger than glass
- Virtually no yellowing
- Easy Installation: Highly flexible will not crack or splinter
- Anti-Drip/Anti-Fog Coating: Aids in condensate removal protecting the crop
- Excellent Fire Rating: Class A/CC1
- Warranty: 15 year warranty against yellowing with 5 year against hail damage

Unit Heater (Modine PTP Series):

- Low profile power vented heater with stainless steel heat exchanger
- Impressive thermal efficiency of 82%
- Standard power exhaust simplifies side-wall or roof venting with small diameter vent pipe
- Permanently-lubricated motor for trouble-free dependability
- 10-year heat exchanger warranty

Air Circulation:

- Horizontal Air Flow fans (HAF) circulate air inside of the greenhouse
- Promotes uniform temperature throughout the greenhouse
- Reduces moisture in the air preventing high humidity and disease

Evaporative Cooling:

The Cooling System is engineered to meet NGMA standards, providing at least 8 CFM/ ft² of floor space under optimal conditions.

- Evaporative cooling uses exhaust fans and a cooling pad to cool outside air and pull it through the greenhouse
- Exhaust fans:
 - Propeller utilizing a cambered - twist blade designed with a unique dihedral tip for higher air flow capacities at less

horsepower.

- Non-overloading design maintains horsepower within catalog range of static pressure, resulting in lower motor load and reduced operating costs.
- Streamlined orifice insures higher air flow capacity.
- Rust protected with a metal wash process and a baked on finish.
- Pre-lubricated oversize ball bearings are double sealed, require no service.
- Improved, more efficient drive assembly and super-duty neoprene belts provide longer service life.
- 5 year warranty on shaft and bearing assembly.
- Built-in thermal overload for low-line voltage protection on all single phase motors.
- Cooling pad system
 - Easy to install UV protected system with stainless steel components and built in water storage tank

Pad Vents:

- Vent installed over cooling pad to seal pad when not in use.
- Consists of heavy duty steel racks with pinions 6' on center with an extra rack at each vent end for added wind support.
- Arched racks prevent integration issues with interior equipment or curtain systems
- All extrusions are heavy duty, designed for easy installation, low maintenance, & the best weather seal possible.

1 3/8" Dia. tubing shaft, fasteners and closure stripping included

ES2 Curtain System (Slope-flat-slope):

- Slope-flat-slope curtain operating truss-to-truss with push-pull steel rack & pinion drive.
- To include channels for leading edge, gathering clips, gutter seals, and mono support wires.
- Push-pull design:
 - Galvanized steel racks & pinions with 1 3/8" continuous push pull tubing
 - Low friction rigid system

Curtain Fabric – Ludvig Svensson Harmony Series

- Energy saving curtain that promotes healthier plants and accelerated production
- High grade light diffusion actively scatters the sunlight to reach deeper – and more evenly – into the crop.
- More light exposure and a lower temperature helps plants and people flourish
- Curtain shall be flame retardant – Warranty to be provided

Drive (RW Series):

- Compact drive units for operating vents, curtain systems
- CSA approved with internal primary safety limit switches

Stationary AND Rolling Top Bench's (Expanded Metal):

- Heavy duty galvanized steel components
- Cross bars support bench top and prevent sagging
- Bench components are factory punched for easy install
- Clean professional appearance
- Expanded Metal Bench Top:
 - Expanded metal $\frac{3}{4}$ " mesh 13 GA hot dipped after expansion for max service life

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Summary of Work Required

DIVISION 13 GREENHOUSE REQUIREMENTS

13 3414 Greenhouse

DIVISION 26 ELECTRICAL

- 26 0500 Common Work Results for Electrical
- 26 0501 Basic Electrical Materials and Methods
- 26 0533 Conduit and Wire
- 26 2416 Branch Circuit Panelboards and Terminal Cabinets
- 26 3323 Emergency Lighting Battery
- 26 6010 Electrical Network Infrastructure

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SECTION 26 0500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the Drawings and/or specified herein. Work includes, but is not necessarily limited to, the following:
 - 1. Examine all other Sections for work related to those other Sections and required to be included as work under this Section.
 - 2. Electrical General Provisions and Requirements for electrical work.
 - 3. Division-1; General Requirements; General Conditions.
- B. Organization of the Specifications into Divisions, Sections and Articles, and arrangement of Drawings shall not control the Contractor in dividing the Contract Work among Subcontractors or in establishing the extent of work to be performed by any trade.

1.02 GENERAL SUMMARY OF ELECTRICAL WORK

- A. The Specifications and Drawings are intended to cover a complete installation of systems. The omission of expressed reference to any item of labor or material for the proper execution of the work in accordance with present practice of the trade shall not relieve the Contractor from providing such additional labor and materials.
- B. Refer to the Drawings and Shop Drawings of other trades for additional details, which affect the proper installation of this work. Diagrams and symbols showing electrical connections are diagrammatic only. Wiring diagrams do not necessarily show the exact physical arrangement of the equipment.
- C. Before submitting a bid, the Contractor shall become familiar with all features of the Building Drawings and Site Drawings, which may affect the execution of the work. No extra payment will be allowed for failure to obtain this information.
- D. If there are omissions or conflicts between the Drawings and Specifications, clarify these points with the District's Representative before submitting bid and before commencing work.
- E. Provide work and material in conformance with the Manufacturer's published recommendations for respective equipment and systems.

1.03 LOCATIONS OF EQUIPMENT

- A. The Drawings indicate diagrammatically the desired locations or arrangements of conduit runs, outlets, equipment, etc., and are to be followed as closely as possible. Proper judgment must be exercised in executing the work so as to secure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structure conditions encountered.

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- B. Where Outlets are placed on a wall, locate symmetrically with respect to each other, furniture, cabinets, and other features or finishes on the wall.
- C. In the event changes in the indicated locations or arrangements are necessary, due to developed conditions in the building construction or rearrangement of furnishings or equipment, such changes shall be made without cost to the Contract, providing the change is ordered before the conduit runs, etc., and work directly connected to same is installed and no extra materials are required.
- D. Lighting Fixtures in mechanical spaces are shown in their approximate location only. Do not install light outlets or fixtures until mechanical piping and ductwork is installed; then install lights in a location to provide best lighting.
- E. Coordinate and cooperate in every way with other trades in order to avoid interference and assure a satisfactory job.
- F. The Location of the existing utilities, building, equipment and conduit shown on the Drawings is approximate. Verify exact locations and routing of existing systems by potholing all trench routes prior to digging the trench. Pothole at least 100 feet ahead of the actual trenching to allow space to alter the new conduit routing to accommodate existing conditions.
- G. Underground Detection Services Existing Utility Structures
 - 1. Detection/location services shall be provided utilizing the latest detection equipment available. Services shall be performed by a company regularly engaged in the business of existing Underground Utility Structure Detection for the past 5-years.
 - 2. Prior to excavation and prior to directional boring the following work shall be performed:
 - a. Contractor to mark excavating and trenching/ directional boring locations and indicate width and depth.
 - b. Locate, by way of vertical and horizontal control dimensions, existing subgrade petroleum product pipes, process piping, conduits, sewer, water, gas, storm drain, electrical, telephone, and irrigation lines in the affected areas of Contract Construction Work.
 - c. Arrange and meet with the District's Representative to review existing underground conditions.
 - d. The proposed route of each excavation shall be continuously surveyed along the entire excavation path using Ground-Penetrating Radar (GPR) operating from the surface grade. The GPR shall detect and map existing underground metal and non-metal, both private and public utility lines, pipes, conduits, conductors, etc. The GPR shall identify the horizontal and vertical location of existing underground conditions located at a depth of up to three meters below finish grade and located with a vertical and horizontal accuracy within ±12-inches of actual condition. The Contractor shall add this information to the existing Conditions Site Plan.
 - 3. Exercise extreme caution in directional boring, excavating and trenching on this site to avoid existing underground utilities and structures, and to prevent hazard to Personnel and/or damage to existing underground utilities or structures. The Contract Documents, Drawings and Specifications do not include necessary components for construction safety, which is the responsibility of the Contractor.

4. Repair/replace, without additional cost to the Contract, and to the satisfaction of the District any existing work damaged that was identified in the Record Drawings provided; Identified by the District's Representative; Identified by the Underground Detection Services performed; or any existing work damaged as a result of failure to comply with all the Referenced Requirements.
 5. The Contractor shall contact Common Ground Alliance (CGA) telephone #811 "Know What's Below-Call Before You Dig" and Underground Service Alert (USA), not less than 72-hours prior to excavation. Contractor shall not excavate until verification has been received from CGA and USA that existing underground utilities serving the site have been located, identified, and marked.
- H. The Locations of existing underground utilities, where shown on Drawings, are shown diagrammatically and have not been independently verified by the District, the District's Representative, the Architect/Engineer. The District, the District's Representative, and the District's Architect/Engineer are not responsible for the location of underground utilities or structures, whether or not shown or detailed and installed under this or any other Contracts. The Contractor shall identify each existing utility line prior to excavation and mark the locations on the ground of each existing utility line.

1.04 AIR CONDITIONING, HEATING, PLUMBING EQUIPMENT WIRING

Provide Electrical Work, Materials, and Control Components required for proper operation of the air conditioning, heating and plumbing systems as indicated on the Electrical, Mechanical, and Plumbing Contract Documents and specified herein.

1.05 PERMITS

Take Out and Pay for all required permits, inspections and examinations without additional cost to the District.

1.06 QUALITY ASSURANCE

- A. Work and Materials shall be in full accordance with the latest Rules and Regulations. The publications shall be included in the Contract Documents Requirements. If a conflict occurs between the following publications and any other part of the Contract Documents, the Requirements describing the more restrictive provisions shall become the applicable Contract definition:
 1. California Code of Regulations Title 24.
 2. California Part 3 "California Electrical Code" CEC, Title 24 and Title 8 "Division of Industrial Safety".
 3. California Building Code – CBC.
 4. California Fire Code – CFC
 5. The National Electrical Code – NEC/NFPA 70.
 6. International Building Code – IBC.
 7. National Fire Protection Agency – NFPA.
 8. National Fire Alarm Code – NFAC/NFPA 72.
 9. Underwriter's Laboratory – UL.
10. Other applicable State and Local Government Agencies laws and regulations.
11. Electrical Installation Standards National Electrical Contractors Association (NECA) and National Electrical Installation Standards (NEIS):
 - a. NECA/NEIS-1: Standard of Practices for Good Workmanship in Electrical Contracting
 - b. NECA/NEIS-101: Standard for Installing Steel Conduit (Rigid, IMC, etc.)

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- c. NECA/NEIS-104: Recommended Practice for Installing Aluminum Building Wire and Cable
 - d. NECA/NEIS-105: Recommended Practice Installing Metal Cable Trays
 - e. NECA/NEIS-111: Recommended Practice Installing Nonmetallic Raceways
 - f. NECA/NEIS-230: Recommended Practice for Installing Motors
 - g. NECA/FOA-301: Standards for Installing and Testing Fiber Optic Cables
 - h. NECA/NEIS-305: Standard for Fire Alarm System Job Practice
 - i. NECA/NEIS-331: Standards for Installing Building and Service Entrance Grounding
 - j. NECA/NEIS-400: Recommended Practice for Installing and Maintaining Switchboards
 - k. NECA/NEIS-402: Recommended Practice for Installing and Maintaining Motor Control Centers
 - l. NEIS/NECA and EGSA-404: Recommended Practice for installing Generator Sets
 - m. NECA/NEIS-405: Recommended Practices for installing and Commissioning Interconnected Generation Systems
 - n. NECA/NEIS-407: Recommended Practice for Installing Panelboards
 - o. NECA/NEIS-408: Recommended Practices for Installing Busway
 - p. NECA/NEIS-409: Recommended Practice for Installing and Maintaining Dry-Type Transformers
 - q. NEIS/NECA and IESNA-500: Recommended Practice for Installing indoor Commercial Lighting Systems
 - r. NEIS/NECA and IESNA-501: Recommended Practice for Installing Exterior Lighting Systems
 - s. NEIS and IESNA-502: Recommended Practice for Installing Industrial Lighting Systems
 - t. NECA/BICSI-568: Standards for Installing Commercial Building Telecommunications System
 - u. NECA/NEIS-600: Recommended Practice Installing Medium-Voltage Cable
- B. All Material and Equipment shall be new and shall be delivered to the site in unbroken packages. All material and equipment shall be listed and labeled by Underwriters Laboratories or other recognized Testing Laboratories, where such listings are available. Comply with all Installation Requirements and restrictions pertaining to such listings.
- C. Work and Material shown on the Drawings and in the Specifications are new and included in the Contract unless specifically indicated as existing or N.I.C. (not in Contract).
- D. Keep a copy of all applicable Codes and Standards available at the job site at all times for reference while performing work under this Contract. Nothing in Plans or Specifications shall be construed to permit work not conforming to the most stringent of Building Codes.
- E. Where a conflict or variation occurs between applicable Codes, Standards and/or the Contract Documents, the provisions of the most restrictive provision shall become the Requirement of the Contract Documents.

1.07 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General

1. Review of Contractor's submittals is for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action shown is subject to the Requirements of the Plans and Specifications. Contractor is responsible for quantities; dimensions which shall be confirmed and correlated at the job site; fabrication processes and techniques of construction; coordination of work with that of all other trades and satisfactory performance of their work.
2. The Contractor shall review each submittal in detail for compliance with the Requirements of the Contract Documents prior to submittal. The Contractor shall "Ink Stamp" and sign each item of the submittal with a statement "CERTIFYING THE SUBMITTAL HAS BEEN REVIEWED BY THE CONTRACTOR AND COMPLIES WITH ALL THE REQUIREMENTS OF THE CONTRACT DOCUMENTS". The Contractor shall clearly and specifically identify each individual proposed substitution, substitution of equal or proposed deviation from the Requirements of the Contract Documents with a statement "THIS ITEM IS A SUBSTITUTION".
The burden of research, preparation of calculations and the furnishing of adequate and complete Shop Drawings information to demonstrate the suitability of Contractor's proposed substitutions and suitability of proposed deviations from the Contract Documents is the responsibility of the Contractor.
3. Departure from the submittal procedure will result in resubmittals and delays. Failure of the Contractor to comply with the Submittal Requirements shall render void any acceptance or any approval of the proposed variation. The Contractor shall then be required to provide the equipment or method without variation from the Contract Documents and without additional cost to the Contract.
4. The Contractor at no additional cost or delays to the Contract shall remove any work, material and correct any deficiencies resulting from deviations from the Requirements of the Contract Documents not approved in advance by the District prior to commencement of work.
5. Shop Drawings submitted by the Contractor, which are not specifically required for submittal by the Contract Documents, or Contractor Shop Drawings previously reviewed and resubmitted without a written resubmittal request to the Contractor, will not be reviewed, considered, or commented on. The respective Shop Drawing submittal/resubmittal will not be returned to the Contractor and will be destroyed without comment or response to the Contractor. The respective submittal shall be considered null and void as being not in compliance with the Requirements of the Contract Documents.
6. Refer to Division-1 for Additional Requirements.

B. Material Lists and Shop Drawings

1. Submit material list and Equipment Manufacturers for review within 35 days of award of Contract. Give name of Manufacturer and where applicable, brand name, type and/or catalog number of each item. Listing of more than one Manufacturer for any one item of equipment, or listing items "as specified", without both make and model or type designation, is not acceptable. Shop Drawings shall not be submitted before review completion of Manufacturers list. The right is reserved to require submission of samples of any material whether or not particularly mentioned herein.

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2. After completion of review of the Material and Equipment Manufacturers list, submit Shop Drawings for review. Shop Drawings shall be submitted in completed bound groups of materials (i.e., all lighting fixtures or all switchgear, etc.). The Contractor shall verify dimensions of equipment and be satisfied as to fit and that they comply with all Code Requirements relating to clear working space about electrical equipment prior to submitting Shop Drawings for review. Submittals, which are intended to be reviewed as substitution or departure from the Contract Documents, must be specifically noted as such. The Requirements of the Contract Documents shall prevail regardless of the acceptance of the submittal.
3. Shop Drawings shall include catalog data sheets, instruction manuals, Dimensioned Plans, elevations, details, wiring diagrams, and descriptive literature of component parts where applicable. Structural calculations and mounting details, signed by a Structural Engineer registered by the State of California, shall be submitted for all equipment weighing over 400-pounds, and shall be in compliance with Title 21 of the California Code of Regulations.
4. Each Shop Drawing item shall be identified with the Specification Section and paragraph numbers, lighting fixture types and Drawing Sheet numbers; the specific Shop Drawing is intended to represent. Shop Drawings 11-inches by 17-inches or smaller in size shall be bound in three ring binders. Divider tabs shall be provided in the three ring binders identifying and separating each separate Shop Drawing submittal item. Shop Drawings larger than 11-inches by 17-inches, Shop Drawing pages/sheets submittals shall be sequentially numbered with unique alphanumeric numbering system to facilitate correspondence referencing identification of individual sheets.
5. The time required to review and comment on the Contractor's submittals will not be less than 14 calendar days, after receipt of the submittals at the office of FBA Engineering. The review of Contractor submittals and return to Contractor of submittals with review comments will occur in a timely manner conditioned upon the Contractor complying with all of the following:
 - a. The submittals contain complete and accurate information, complying with the Requirements of the Contract Documents.
 - b. Contractor's submittals are each marked with Contractor's approval "stamp", and with Contractor signatures.
 - c. The submittals are received in accordance with a written, Shop Drawing submittal schedule for each submittal. The Contractor distributes the schedule not less than 35-calendar days in advance of the Shop Drawing Submittals, and the schedule identifies the calendar dates, the Contractor will deliver the various submittals for review.
6. Shop Drawings shall include the Manufacturers projected days for shipment from the factory of completed equipment, after the Contractor releases the equipment for production. It shall be the responsibility of the Contractor to insure that all material and equipment is ordered in time to provide an orderly progression of the work. The Contractor shall notify the District's Representative of any changes in delivery, which would affect the Project completion date.
7. Submittal Identification
 - a. Each submittal shall be dated: with submittal transmission date; sequentially numbered and titled with submittal contents identification and applicable Specification/Drawing references (i.e., *Submittal dated: 5/12/19 Submittal #4 Contents: Branch Circuit Panelboards Sheet #E5.1 and Transformers Specification Section 260500 Paragraph 2.11, etc.*).

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- b. Each resubmittal shall be dated: with original submittal date and resubmittal transmission dates; sequentially numbered with original submittal number and sequential resubmittal revision number and titled with submittal contents identification and applicable Specifications/ Drawing references (*i.e., Original Submittal Date: 5/12/98 Resubmittal Date: 10/9/19 Original Submittal #4 Resubmittal Revision R2 Contents: Transformer Resubmittal Specification Section - 260500 Paragraph 2.11, etc.*).
 - c. Contractor shall provide a written response narrative with each resubmittal. Describe each response-action, resubmittal addition, change and deletion. Correspond to each response to A/E specific review comment.
- C. The Contractor shall be responsible for incidental, direct and indirect costs resulting from the Contractor's substitution of; or changes to; the specified Contract Materials and Work.
- D. The Contractor shall pay, upon request by the District's Representative, a fee for the District's Representative time involved in the review of substitution submittals and design changes resulting from the Contractor's requested substitutions. The fee shall be not less than \$125.00 per hour but, in no case, less than stated in Division-1, whichever is greater.
- E. Maintenance and Operating Manuals
- 1. The Contractor shall furnish three copies of type-written maintenance and operating manuals for all electrical equipment, fire alarm equipment, sound system equipment, etc., to the District.
 - 2. Instruct the District's Personnel in correct operation of all equipment at completion of project. Provide the quantity and duration of instruction class as specified; but in no case less than two 4-hour duration separate instruction classes for each individual equipment group furnished as part of the Contract. Instruction classes shall be presented by Manufacturer's Authorized Field Service Engineer at the project site. Instruction class size shall be at the District's discretion, not less than one or more than fifteen students shall attend each instruction session. Submit fifteen written outline copies of the proposed instruction class curriculum, 14-days prior to the class-scheduled dates.
 - 3. Maintenance and operating manuals shall be bound in three-ring, hard-cover, plastic binders with table of contents. Manuals shall be delivered to the District's Representative, with an itemized receipt.
- F. Portable or Detachable Parts: The Contractor shall retain in his possession, and shall be responsible for all portable and detachable parts or portions of the installation such as fuses, keys, locks, adapters, locking clips, and inserts until final completion of Contract Work. These parts shall then be delivered to the District's Representative with an itemized receipt.
- G. Record Drawings (Additional Requirements)
- 1. Provide and maintain in good order a complete set of Electrical Contract "Record" prints. Changes to the Contract to be clearly recorded on this set of prints. At the end of the Project, transfer all changes to one set of transparencies to be delivered unfolded to the District's Representative.
 - 2. The actual location and elevation of all buried lines, boxes, monuments, vaults, stub-outs and other provisions for future connections shall be referenced to the

building lines or other clearly established base lines and to approved bench marks. If any necessary dimensions are omitted from the Record Drawings, the Contractor shall, at the Contractor's own expense, do all excavation required to expose the buried work and to establish the correct locations.

3. The Contractor shall keep the "record" prints up to date and current with all work performed.
4. Refer to Division-1 for Additional Requirements.

1.08 CLEANING EQUIPMENT, MATERIALS, PREMISES

All Parts of the equipment shall be thoroughly cleaned of dirt, rust, cement, plaster, etc., and all cracks and corners scraped out clean. Surfaces to be painted shall be carefully cleaned of grease and oil spots and left smooth, clean and in proper condition to receive paint finish.

1.09 JOB CONDITIONS - PROTECTION

Protect all Work, Materials and Equipment from damage from any cause whatever and provide adequate and proper storage facilities during the progress of the work. Provide for the safety and good condition of all the work until final acceptance of the work by the District and replace all damaged or defective work, materials, and equipment before requesting final acceptance.

1.10 EXCAVATION, CUTTING, BACKFILL AND PATCHING ADDITIONAL REQUIREMENTS

A. General

1. Perform excavation, cutting, backfill, core drilling, directional boring, and patching of the construction work required for the proper installation of the electrical work.
2. Patching shall be of the same material, thickness, workmanship, and finish as existing and accurately match-surrounding work to the satisfaction of the District's Representative.
3. Prior to penetrating, coring, drilling or cutting existing building elements, concrete and/or masonry, provide imaging equipment examinations of each specific location. The imaging process shall identify existing internal embedded components and locations, including structural elements/anchors, conduit, and piping that are present. Do not penetrate or damage the existing internal embedded elements. Imaging shall employ one of the following, with GPR methodology preferred:
 - a. Non-invasive imaging employing high frequency, Ground Penetrating Radar (GPR), single side echo reflection technology.
 - b. Non-invasive imaging employing x-ray radiography, through-and-through imaging technology.

B. Excavation Temporary Cover

1. Excavations for Contract Work occurring in streets, vehicular drive areas, parking lots, sidewalks; any paved surface; or any area accessible to the public; provide temporary steel plating and shoring support for the plates, to completely cover the excavations under one or more of the following conditions:
 - a. Excavation shall not remain "open" for more than 4-calendar days; provide temporary plating.
 - b. Excavation shall not be "open" over weekends (Saturday, Sunday) or Holidays; provide temporary plating.

2. The temporary plating shall be a minimum of 0.75-inch thickness steel, but in no case shall the thickness be less than required to support AASHTO-H20 traffic loading.
3. Provide a minimum of two 100% open lane(s) (12-foot lane width) for vehicular traffic at all times during construction, for vehicle access to all areas.

1.11 IDENTIFICATION

- A. Equipment Nameplates
 1. Panelboards, terminal cabinets, circuit breakers, disconnect switches, starters, relays, time switches, contactors, push-button control stations, and other apparatus used for the operation or control of feeders, circuits, appliances, or equipment shall be properly identified by means of descriptive nameplates or tags permanently attached to the apparatus and wiring.
 2. Provide nameplate label on electrical service entrance equipment describing available short circuit information calculated by the Contractor, including:
 - a. Calculation date, month-day-year.
 - b. Calculate maximum available short circuit fault current.
 - c. Description of parameters and changes affecting the Requirements for recalculation of the fault current information.
 3. Electrical equipment including switchgear, switchboards, electric panels and control panels, motor control centers, combination motor starters, transformers, disconnects, etc., shall each be labeled by the Manufacturer with "Electric-Arc-Flash" warning signs. The signs shall explain a hazard to personnel may exist if the equipment is worked on while energized or operated by personnel while energized. The sign shall instruct personnel to wear the correct Protective Equipment/clothing (PPE) when working "Live", or operating "Live" electrical equipment and circuits.
 4. Nameplates shall be engraved laminated phenolic. Shop Drawings with dimensions and format shall be submitted before installation. Attachment to equipment shall be with escutcheon pins, rivets, self-tapping screws or machine screws. Self-adhering or adhesive backed nameplates shall not be used.
 5. Provide black-on-white laminated plastic nameplates engraved in minimum $\frac{1}{4}$ -inch high letters to correspond with the designations on the Drawings. Provide other or additional information on nameplates where indicated.
- B. Plates: All cover and device plates shall be furnished with engraved or etched designations under any one of the following conditions (minimum character size not less than 0.188 inch. Engraving shall indicate circuits and equipment controlled or connected):
 1. More than two devices under a common coverplate.
 2. Lock switches.
 3. Pilot switches.
 4. Switches in locations from which the equipment or circuits controlled cannot be readily seen.
 5. Manual motor starting switches.
 6. Where so indicated on the Drawings.
 7. As required on all control circuit switches, such as heater controls, motor controls, etc.
 8. Receptacles other than standard 15-amp 120-volt duplex receptacles; shall indicate circuit voltage, ampere, phase and source circuit number.

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9. Where outlets or switches are connected to emergency power circuit; provide panelboard and circuit number engraved on plate.
 10. Low voltage and signal system outlets.
- C. For equipment and access doors or gates to equipment containing or operating on circuits of more than 100 volts AC or DC nominal. Provide red-on-white laminated warning signs engraved in $\frac{1}{2}$ -inch high letters to read: "DANGER - 480 (*or applicable voltage*) VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".
- D. Wire and Cable Identification
1. Provide identification on individual wire and cable including signal systems, fire alarm, electrical power systems (each individual phase, neutral and ground), empty conduit pull ropes, and controls circuit.
 2. Permanent identification shall be provided at each termination location, splice location, pullbox, junction box and equipment enclosure.
 - a. Individual wire and cable larger than #6AWG or 0.25-inch diameter, shall be provided with polypropylene identification tag holders, with yellow polypropylene tags interchangeable black alphanumeric characters, character height 0.25 inch. Attach identification tags with plastic "tie" wraps, minimum of two for each tag. As manufactured by Almetek Industries—"EZTAG" Series; or TECH Products - "EVERLAST" Series.
 - b. Individual wire and cable #6AWG and smaller or smaller than 0.25 inch diameter, shall be provided with water and oil resistant, flexible, self-laminating pressure sensitive machine embossed plastic tags that wrap a minimum of 360 degrees around the wire/cable diameter. The entire tag shall then be covered with a clear flexible waterproof plastic cover wrapped a minimum of 540 degrees around the wire/cable diameter and completely covering the identification. As manufactured by Brady Identification; or 3M; or Panduit.
 - c. Each identification tag location shall indicate the following information: circuit number, circuit phase, source termination and destination termination equipment name (or outlet number as applicable).
 3. Install permanent identification after installation /pulling of wire/cable is complete, to prevent loss or damage to the identification.
- E. Cardholders and Cards shall be provided for circuit identification in panelboards. Cardholders shall consist of a metal frame retaining a clear plastic cover permanently attached to the inside of panel door. List of circuits shall be typewritten on card. Circuit description shall include name or number of circuit, area, and connected load.
- F. Junction and Pullboxes shall have covers stenciled with box number when shown on the Drawings, or circuit numbers according to panel schedule. Data shall be lettered in a conspicuous manner with a color contrasting to finish.

1.12 TESTING

- A. The Contractor shall obtain an independent Testing Laboratory, provide all instrumentation and perform tests on the electrical system and equipment as hereinafter described and further directed by the District's Representative. The test shall be performed after the completion of all electrical systems included in the Contract Scope of Work. All tests shall be recorded and documented and submitted to the District's Representative for review.

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1. All equipment and personnel required for set-up and testing shall be provided by the Contractor.
- B. Test for Phase to Ground and Neutral Condition:
 1. Open main service disconnects.
 2. Isolate the system neutral from ground by removing the neutral disconnects link located in the service switchboard.
 3. Close all submain disconnects.
 4. Close all branch feeder circuit breakers.
 5. Turn all switches to "on" position, unplug all portable equipment from outlet receptacles.
 6. Measure the resistance of each phase to ground and phase to neutral. A properly calibrated "megger" type test instrument shall be used. The test voltage shall be a nominal 500 volts.
 7. Record all readings after 1-minute duration and document into a complete report.
 8. Isolating Grounds: In the event that low resistance ground neutral connections are found in the system, they shall be isolated and located by testing each circuit individually as outlined above. Make proper corrections to restore the resistance values to an acceptable value.
- C. Method of obtaining ground resistance shall be in accordance with the latest edition of the James G. Biddle (Plymouth Meeting, Pennsylvania) manual published on this subject.
 1. Perform "fall-of-potential" three point tests on the main grounding electrode of system per IEEE Standard No. 81, Section 8.2.1.5. when suitable locations for test rods are not available, a low resistance dead earth or reference ground shall be utilized.
 2. Perform the two point method test per IEEE Standard No. 81, Section 8.2.1.1, to determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
- D. The Testing, Calibrating and Setting of all ground and ground fault equipment, circuit breakers, circuit device protection relays, and meters adjustable settings shall be by an independent Testing Laboratory. Set as recommended by the respective Manufacturer and coordination study so as to be coordinated with other protection devices within the electrical design. Bound and tabulated copies of the test and settings shall be sent to the District's Representative.
- E. Ampere and Voltage Measurements
 1. Measure and record ampere and line voltage measurements under full load on all panel feeders, switchboard, and switchgear feeders, motor control centers and motor circuits provided in the Contract. Record measurements at the equipment tested and submit to the District's Representative for review.
 2. Ampere voltage readings shall be:
 - a. Phase A-B, A-C and B-C.
 - b. Phase A-Neutral, B-Neutral and C-Neutral.
 3. The ampere and voltage readings shall be not less than 20-minutes duration for each test. Record and submit the measured minimum, maximum and 20-minute average for each ampere and voltage value and test location. Voltage and ampere measurements shall occur at the connected load end of each respective feeder, not at the source of supply end of each feeder.

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4. Test equipment shall be accurate within plus or minus 1%.
 5. Branch circuit devices 40 amp or less and motor loads ten horsepower or smaller are excluded from Ampere and Voltage Testing Requirement.
 6. If, in the opinion of the District's Representative, the voltages and regulations are not met within acceptable limits, make arrangements with the serving utility for proper electrical service. Retest feeder line voltages, and submit to District's Representative for review, after the Utility Company has completed corrective actions. Reset "voltage taps" on transformers provided or modified as part of the Contract Work, to adjust line voltages to within acceptable values, as directed by the District's Representative.
- F. The Contractor shall complete the following work before any electrical equipment is energized.
1. All equipment shall be permanently anchored.
 2. All bus connections and conductor/wire connections shall be tightened per Manufacturer's instructions and witnessed by the District's Representative.
 3. All ground connections shall be completed and identified. Perform and successfully complete all required megger and ground resistance tests.
 4. Feeders shall be connected and identified.
 5. The interiors of all electrical enclosures including busbars and wiring terminals shall be cleaned of all loose material and debris, paint, plaster, cleaners or other abrasive's over spray removed and equipment vacuumed clean. The District's Representative shall observe all interiors before covers are installed.
 6. All wall, ceiling, and floor work and painting shall be completed within areas containing electrical equipment prior to installation of equipment. The equipment indoor rooms and spaces shall be weather-tight and weather protected from environmental incursions.
 7. All doors to electrical equipment rooms shall be provided with locks in order to restrict access to energized equipment.
 8. Electrical spaces and rooms shall not be used as storage rooms after power is energized.
 9. Outdoor electrical equipment enclosures and housings shall be weather protected.
 10. The electrical system time current Coordination and Arc-Fault Study shall be complete for circuit breakers, ground relays sets, and circuit relay sets, fuses; set-up, tested and calibrated accordingly.

1.13 POWER OUTAGES

- A. All Electrical Services in all occupied facilities of the Contract Work are to remain operational during the entire Contract Period. Any interruption of the electrical services for the performance of this work shall be at the convenience of the District and performed only after consultation with the District's Representative. Work involving circuit outages shall be only at such a time and of such a duration as approved in writing. Work involving circuit outages for the work required to connect new equipment and disconnect existing equipment shall be performed at the convenience of the District.
- B. Contract Work involving outages or disruption of normal function in electrical power systems, telephone/communication systems, fire alarms, shall be performed during the following time periods. The Contract Work shall be phased to limit outages in the respective systems to the stated periods:

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1. 11:30 p.m. Friday to 11:30 p.m. Sunday of the same weekend. Work shall occur on multiple weekend periods if a single weekend is not sufficient time to complete the work.
 2. The Contract work involving outages shall be phased in multiple work time units, to comply with the permitted outage limitations.
- C. Work involving system outages to the building fire alarm system shall be performed only after consultation with the District and shall be only at such a time and of such duration as approved in writing. Contractor shall provide continuous "Fire-Watch" during fire alarm system outages and comply with AHJ "Fire-Watch" Requirements.
- D. Provide overtime work; double shift work; night time work; Saturday, Sunday, and holiday work to meet outages schedule.
- E. Provide temporary electrical power to meet the Requirements of this Article.
- F. Any added costs to Contractor due to necessity of complying with this Article shall be included in the Contract Scope of Work.
- G. When electrical work involving power disruptions to existing areas is initiated, the work shall proceed on a continuous basis without stopping until electric power is restored to the affected areas.
- H. The Contractor shall request in writing to the District's Representative a minimum of 3-weeks in advance, for any proposed electrical outage.

1.14 TEMPORARY ELECTRICAL POWER

- A. Provide Temporary Electrical Power if work requiring power outages cannot be completed in time permitted and approved by the District's Representative.
- B. Temporary Electrical Power shall be a standby diesel engine generators. Voltage, frequency, regulation, etc. shall be equal to that of normal utility source. Exhaust system shall have a critical silencing muffler. Generator voltage shall match the existing secondary voltage required at the site. The Contractor shall furnish all necessary cables, switches, etc., to make all required connections to existing panels, feeders, etc. Generator shall be sized to adequately carry the demand load. If record of demand load is not available, size generator to match corresponding transformer, maximum capacity circuit as directed by the District's Representative.
- C. After completion of required usage of the temporary generators, prior to completion of the Project, the Contractor shall remove the generators. All temporary cables, switches, etc. shall be removed and all permanent equipment left in satisfactory condition.
- D. Each Generator shall be housed in security type sound attenuated housing to prevent access by unauthorized personnel. Temporary power cables, connections, etc. shall be protected from unauthorized personnel.
- E. The Contractor shall be responsible for complete operation of the generator including Personnel, fuel supplies, proper safety precautions, etc. generator shall not be left unattended while in operation.

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- F. The Contractor shall provide temporary construction lighting and power as required in areas where work is being performed. Temporary power arrangements, outages, installation, work schedules, etc., shall be submitted in writing 3-weeks prior to requested outage date, and approved by the District's Representative prior to start of work.

1.15 ASBESTOS, POLYCHLORINATED BIPHENYL (PCB) OR HAZARDOUS WASTE

- A. It is understood and agreed that this Contract does not contemplate the handling of asbestos, PCB or any hazardous waste material. If asbestos, PCB or any hazardous waste material is encountered, notify the District's Representative immediately. Do not disturb, handle or attempt to remove.
- B. Lighting Fixture Demolition Hazardous Materials
1. The removal of existing lighting fixtures will generate Hazardous Material Waste Disposal Contract Documents.
 - a. The existing lighting fixture ballast contains PCB material.
 - b. The existing lighting fixture lamps contain mercury.
 - c. The existing lighting fixture internal wire insulation may contain asbestos.
 2. Remove, handle, store, contain, dispose of and document the hazardous materials resulting from existing lighting fixtures work, as part of the Contract Requirements.

1.16 TIME/CURRENT COORDINATION, SHORT CIRCUIT, ARC-FLASH AND SERIES RATED EQUIPMENT

- A. Series Rated Equipment.
1. Circuit Protective Devices Identified as "Series Rated" or "Current Limiting" (i.e., CLCB - Current Limiting Circuit Breaker; CLF - Current Limiting Fuse, etc.) shall be series rated and tested (UL 489 and CSA5) by the Manufacturer with all equipment and circuit protective devices installed downstream of the identified series rated or current limiting device.
 2. Provide nameplates on all equipment located downstream, including the CLCB and CLF devices, to comply with CEC/NEC paragraphs 110-22 and 240-83 "CAUTION SERIES RATED SYSTEM - NEW DEVICE INSTALLATIONS AND REPLACEMENTS SHALL BE THE SAME MANUFACTURER AND MODELS".
- B. Short Circuit, Coordination and Arc-Flash
1. Perform Engineering Analysis and submit engineered settings for each equipment location, fuse and circuit breaker device, showing the correct time and current settings to provide the selective coordination within the limits of the specified equipment. Shall comply with the latest application Standards of IEEE and ANSI. Provide electrical system short circuit worst case bolted-fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the Coordination Analysis recommendations. Provide Electric Arc-Flash calculations as part of the Coordination Analysis recommendations.
 2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an Engineering Narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six copies.

3. The goal is to minimize an unexpected but necessary electrical system outage and personnel exposure to the smallest extent possible within the fault occurrence location, using the specified Contract Equipment. Shall comply with, but not limited to:
 - a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
 - b. IEEE-399, Recommended Practices for Industrial and Commercial Power System Analysis.
 - c. IEEE-1584, Guide to Performing Arc-Flash Hazard Calculations.
 - d. CEC/NEC
4. Provide permanent warning labels on each equipment location. The labels shall describe Arc-Flash, Short-Circuit and Time/Current Coordination, including safety precautions and protective clothing. Also described actions to be taken if any circuit changes or equipment modifications occur.
5. Shall be submitted with the Shop Drawing submittals for the respective equipment.
6. The Contractor shall independently contact the serving Utility Company to obtain the current system short circuit amps or available fault current.
7. The Contractor shall independently obtain As-Built Drawings for the existing infrastructure to establish lengths. If As-Built Drawings are no available, the Contractor shall research existing conditions and make reasonable but conservative estimates of conductor length. Where existing conductors have been re-used, the Contractor shall confirm conductor quantity, size, and conduit type.

1.17 INDEPENDENT TESTING LABORATORY

- A. Testing Laboratories Definition
 1. The Testing Laboratory shall meet Federal OSHA criteria for accreditation of Nationally Recognized Testing Laboratories (NRTL) Title 29 Part 1907 and 29 CFR-1910.
 2. Membership in the National Electrical Testing Association (NETA) shall also constitute acceptance of meeting said criteria, for testing of electrical systems.

1.18 EQUIPMENT SEISMIC AND WIND LOAD REQUIREMENTS (ADDITIONAL REQUIREMENTS)

- A. Refer to Structural, Architectural, and Soils Report Contract Documents for Additional Requirements.
- B. General
 1. Equipment supports and anchorage's provided as part of the Contract shall be designed, constructed and installed in accordance with the Earthquake Regulations of the California Building Code (CBC), International Building Code (IBC).
 2. Provide equipment anchorage details, coordinated with the equipment mounting provision, prepared, signed and "stamped" with PE registration in good standing, by a Civil or Structural Engineer licensed as a Professional Engineer (PE) in the State of California.
 3. Mounting recommendations shall be provided by the Manufacturer based upon approved shake-table tests used to verify the seismic design of that type of equipment.

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4. The Equipment Manufacturer shall document the details necessary for proper wind-load and seismic mounting, anchorage, and bracing of the equipment for floor, ceiling, and wall/back installation location.
 5. Seismic performance shall be based on actual install location of the respective equipment in the building and height above or below grade.
 6. The Seismic Requirements are typical for each equipment item exceeding 19-pounds, including but not limited to the following:
 - a. Switchgear, switchboards, and motor control equipment
 - b. Transformers
 - c. Equipment racks and terminal cabinets
 - d. Panels
 - e. Conduits with floor, ceiling or wall attachment support and conduits with suspension attachments.
 - f. Busway, wire way and cable tray
 - g. Uninterruptable Power Supplies (UPS)
 - h. Inverters
 - i. Generators and related equipment
 - j. Lighting equipment
 - k. Fire alarm equipment
- C. Certification
1. Electrical Equipment Manufacturers and Contractor shall provide Special Seismic Certification (SCC) for each specific equipment configuration with shake-table verification, all furnished as part of the Contract Documents Requirements. The SCC shall include the specific installation location characteristics of the respective equipment including as follows:
 - a. Ground or floor attachment
 - b. Wall attachment
 - c. Ceiling attachment
 - d. Roof attachment
 2. Wind Loading
Electrical equipment and anchorages shall withstand the wind-load imposed at the install location. Wind Loading Withstand Requirements shall apply to all electrical equipment installed in outdoor locations and to all electrical equipment exposed to the weather. The equipment shall be tested and certified by the Manufacturer and Contractor. The Wind-Load Withstand Qualification of the equipment and anchorages shall be verified by the following methods:
 - a. Aerodynamic wind tunnel test method.
 - b. Analytical calculation method, for oversized equipment too large for wind tunnel test method.
 3. The wind-load withstand rating and the SCC shall comply with the Requirements of the Authority Having Jurisdiction (AHJ), and include the latest revisions, but not limited to the following:
 - a. American Society of Civil Engineers; ASCE-7
 - b. CBC/IBC; including but not limited to Sections 1702, 1708, 1709, 1708A and 1709A.
 - c. California Office of Statewide Health Planning and Development OSHPD; OPA-Preapproval of Anchorage; Code Application Notice CAN 2-1708A.5 and OSP-Special Seismic Certification Approval.
 - d. US Department of Homeland Security; FEMA- (installing seismic restraints for electrical equipment).

D. Wall Mounted Electrical Equipment

1. Surface Mounted Equipment

- a. Provide multiple horizontal sections of metal "C" channels for support and attaching wall mounted equipment to walls. Channels shall provide "turned lips" at longitudinal edges to hold "lock-in" fasteners and shall comply with ANSI-1008 and ASTM-A569 latest revision. The channels shall be steel hot dip zinc galvanized. As manufactured by Unistrut or Kindorf.
- b. The "C" channels shall be positioned horizontally within 3-inches of the top and bottom of each, equipment section cabinet and located behind each Equipment Vertical Section. Provide additional intermediate "C" channels at not less than 36-inches on center between the "top" and "bottom" "C" channel positions, located behind each equipment vertical section.
- c. The "C" channels shall be of sufficient length to provide connection to not less than two vertical structural wall framing elements separated by not less than 16-inches; but in no case shall the "C" channel length be less than the width of the respective equipment Section.
- d. Attach the "C" channels to the wall structural elements after the wall, finish surface, installation (including painting) is complete.
- e. Attach the "C" channels with fasteners to the building wall framing structural elements as follows: welded to steel framing; bolted to wood framing; cast in place concrete inserts for masonry and concrete construction; drilled "afterset" expansion anchors for existing masonry and concrete construction.
- f. Attach the equipment to the "C" channels with threaded and bolted fasteners to "pre-locate" and lock into the channel "turned lips" and channel walls.

2. Flush mount equipment

- a. Provide anchor attachment of equipment into adjacent wall structural elements.

E. Housekeeping Pad

1. Provide cast-in-place, steel re-enforced concrete raised "housekeeping" pads under all floor standing electrical equipment (except data network equipment racks).
2. Pad sizes
 - a. The raised housekeeping pad height shall extend 4-inches above the surrounding finished floor elevation for interior building locations.
 - b. The pad shall extend 8-inches below finish grade plus 4-inches above finish grade for outdoor equipment location on grade.
 - c. The pads shall extend 7-inches past the "footprint" edge of the respective floor standing equipment.
3. Anchor equipment to pads. Anchor pads to the building structural floor. Equipment pad, equipment re-enforcing and equipment anchoring shall comply with Seismic Earthquake Requirements and Wind Load Requirements.
4. Unless shown otherwise on Drawings. The equipment housekeeping pad steel re-enforcing shall consist of two layers of number 4-size steel-rebar laid horizontally and uniformly spaced 6-inches on center. Position rebar in two directions (90-degrees opposed) and centered inside the concrete housekeeping pad. Horizontal rebar shall extend to within 3-inches of the edge

of the concrete pad in all directions. Metal wire "tie-wrap" shall be provided at each rebar crossing.

5. Equipment anchor attachments shall extend through the housekeeping pad and into the structural concrete below the pad a minimum of not less than 2-inches.

1.19 ELECTRICAL WORK CLOSEOUT

- A. Prepare the following items and submit to the District's Representative before final acceptance.
 1. Two copies of all test results as required under this Section.
 2. Two copies of local and/or State Code Enforcing Authority's Final Inspection Certificates.
 3. Copies of Record Drawings as required under the General Conditions, pertinent Division One Sections and Electrical General Provisions.
 4. Two copies of all receipts transferring portable or detachable parts to the District's Representative when requested.
 5. Notify the District's Representative in writing when installation is complete and that a final inspection of this work can be performed. In the event any defect or deficiencies are found during this final inspection they shall be corrected to the satisfaction of the District's Representative before final acceptance can be issued.
 6. List of spare fuses and locations identified by equipment name and building designation.
 7. Prior to energizing, retighten to the proper torque, each circuit conductor lug landing, each bus bar (phases, neutral and ground) and circuit protection device threaded connections in all switchboards, switchgear, motor control centers, transformers, busways, disconnect switches, motor starters, motor terminals and panelboards, after the equipment is installed/connected and prior to energizing the equipment. The torque values shall comply with Manufacturer's recommendations.
- B. Electrical Power Single Line Diagrams – SLD
 1. Provide single line diagrams showing the Contract Document work complete electrical power system (normal and emergency). SLD shall show interconnection circuits, electrical equipment, panels, and circuit protection devices, nominal 50% ($\frac{1}{2}$ -size) approximately 18-inches by 24-inches. Show installed voltages and electrical capacity sizes.
 2. SLD shall be mounted in metal (picture frame) rigid enclosure frame with rigid-backing (backer-board) and clear/transparent front, for hanging on wall. Provide clear transparent cover over SLD inside the frame.
 3. Provide a wall-hung (± 48 -inches) SLD in each "main" and "sub" electrical equipment room. If wall space is limited, alternatively securely attach SLD frame to room door facing into the respective electrical room.

**END OF SECTION 26 0500
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SECTION 26 0501

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the Drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
 - 1. Examine all other Sections for work related to those other Sections and required to be included as work under this Section.
 - 2. General Provisions and Requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. Submit Product Data Sheets for all outlet boxes, floor boxes, wiring devices, device plates, relays, contactors, timeswitches, and disconnects fuses.
- B. Submit Detailed Shop Drawings including Dimensioned Plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature for all component parts for transformers, relays, time clocks, and photocells.
- C. Submit Transformer Test Reports.
- D. Submit Material List for Outlet boxes.

PART 2 PRODUCTS

2.01 OUTLET AND JUNCTION BOXES

- A. General:
 - 1. Flush or concealed outlet boxes and junction boxes.
 - a. Non-masonry and/or non-concrete locations provide pressed steel boxes. Steel thickness not less than 0.062-inch, hot-dip galvanized. Knockout (KO) type with conduit entrances and quantity size to match conduits shown connecting to respective junction box and outlet box.
 - b. UL-514 listed and labeled.
 - c. Minimum required box depth is exclusive of extension-ring depth.
 - d. Provide all boxes with matching cover plates. Cover plates shall be gasketed water-tight in wet and outdoor locations.
 - e. Boxes installed in masonry or concrete shall be UL "concrete-tight" approved for installation in concrete, and shall allow the placing of conduit without displacing reinforcing bars.
 - 2. Provide boxes of proper code size for the number of wires or conduits passing through or terminating therein. In no case shall box be less than 4.0-inches square by 2.125-inches deep, unless specified elsewhere or noted otherwise on the Drawings. 2.5-inches minimum depth for box width's exceeding 2-gang.

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3. Increase the minimum outlet box size to 4.69-inches square by not less than 2.125-inches deep, where one or more of the following conditions occurs:
 - a. More than two conduits connect to the outlet box.
 - b. Circuit or Conduit "homerun" connects to outlet box.
4. Signal, Communication and Low Voltage:
 - a. Individual audio/visual, telephone, computer or data outlets: 4.69-inches square by 2.125-inch deep minimum with 2-gang extension ring on flush boxes.
 - b. Combination signal/telephone/data or computer outlets: 4.69-inches square by 2.125-inch deep minimum with 2-gang wide extension ring on flush boxes.
5. Junction boxes shall be sized to comply with the following:
 - a. Code Requirements size based on the conduit quantities, conduit sizes and wire-fill connected to the junction box.
 - b. Junction box minimum size shall not be less than 4.69-inches by 4.69-inches by 2.5-inches deep, but not less than size indicated on the Drawings or required by Code.
6. Provide extension rings on flush outlets to finish face of extension ring flush with finished building surfaces. Extension ring shall match outlet box construction and contain "attachment mounting-tabs" for wiring devices. Extension rings shall be "screw-attached" to respective outlet box and maintain "ground" bonding continuity.
7. Outlet boxes installed in outdoor locations, or in wet locations, or in concrete/masonry, shall be cast-iron or cast-bronze, with threaded conduit hubs. UL rated for wet locations.
 - a. Aluminum boxes shall NOT be in contact with concrete or masonry. Die-cast aluminum or cast aluminum water-tight electrical outlet boxes with threaded hubs may be provided as an alternate to cast-iron or cast-bronze outlet boxes, only where one or more of the following conditions occur:
 - 1) Outdoor locations above finish grade.
 - 2) Indoor wet locations surface or flush in walls or ceilings.
8. Provide fixture-supporting device in outlet boxes for surface mounted fixtures as required.
9. Provide solid gang boxes for three or more devices, typical for line and low voltage switches, receptacles, low voltage/signal outlets, etc. for mounting devices behind a common device plate.
10. Provide isolation barriers in outlet boxes:
 - a. Between line voltage and low voltage devices.
 - b. Where more than one device is installed in an outlet box.
 - c. Between 277-volt and 120-volt devices.
 - d. Between devices connected to emergency and non-emergency circuits of all voltages.
11. Outlet boxes installed penetrating into fire rated walls, fire rated floors, fire rated ceilings and all fire rated construction. The outlet boxes shall be UL listed, classified and labeled, for fire rated and temperature rated penetration of the respective fire rated surface and fire rated construction. The outlet box fire rating and temperature rating shall equal or exceed the fire/temperature rating of the surface/construction being penetrated. Provide UL listed and labeled supplemental fire and temperature protection to maintain ratings:
 - a. Wall and ceiling penetrations, tumescent fire wrap (external or internal of outlet box).
 - b. Floors provide subfloor supplemental fireproofing below floor box.

12. Outlet boxes installed in floors. The floor outlet boxes shall be UL listed and labeled for Scrub Water Exclusion Requirements, including but not limited to tiles, carpeting and exposed wood and concrete floor fishes.
 13. Outdoor flush in wall device outlet boxes:
 - a. Flush in wall, gasketed water tight, with hinged, key locking cast metal, self-closing cover. Tamper resistant and vandal resistant. UL-listed and labeled for installation in masonry, cast-in-place concrete and hollow-framed walls.
 - b. Flush cast-iron or cast-bronze device back-box, 4.68-inch square by 2.25-inch deep.
 - c. Internal metal adapter plate and wiring device types, in the box as indicated on the Drawings.
 - d. As manufactured by Legrand/Pass and Seymour #4600 Series; or C.W. Cole #310 Series.
 14. Refer to Architectural and Structural Contract Documents and details for additional Box and Install Requirements.
- B. Surface Outlet Boxes
1. Surface mounted outlet boxes, cast iron Type FS or FD, with threaded hubs as required. Box interior dimensions and interior volume capacity not less than required for "press steel boxes", and "sheet steel boxes". Provide plugs in all unused openings. Provide weatherproof gaskets for all exterior boxes.

2.02 PULL BOXES

- A. General
1. Sizes as indicated on the Drawings and in no case of less size or material thickness than required by the Governing Code and AHJ.
 2. Exercise care in locating pull boxes to avoid installation in drain water flow areas and to clear existing condition interferences.
 3. UL listed and labeled for electrical circuits.
- B. General Purpose Sheet Metal Pullbox
1. General purpose sheet steel pull boxes: Install only in dry protected locations with removable screw covers. Manufacturer's standard rust proofing and baked enamel finishes.
 2. Weatherproof sheet steel pull boxes: Fabricate of Code gauge steel. All surfaces interior and exterior hot-dip galvanized steel. Gasketed weather-tight cover of same material. Manufacturer's standard baked exterior enamel finish.
- C. Concrete Pull Boxes and Hand-holes
1. H-20 traffic rated box and cover, pre-cast concrete, steel reinforced pull boxes and hand-holes. Provide complete with pulling irons, hot-dip galvanized metal traffic cover with hot-dip galvanized metal cover frame, pull-box concrete base with sump. Four cable full height wall racks with porcelain blocks.
 2. Boxes shall be "Intercept" type with multiple sections and extension cable-intercepts at both ends of box. Refer to Drawings for box size.
 3. Covers shall be flush bolt down. Covers weighing more than 40-pounds shall be split cover type "Torsion-Spring" assist, hinged open-close.
 4. Box covers shall comply with Federal ADA, UL, State and Local AHJ for slip resistance. Provide bead weld on cover to pull box to indicate services within pull box (i.e., "480/277-VOLT, 3-PHASE, 4-WIRE ELECTRICAL" OR "SIGNAL/TEL/ P.A./CLOCK/FIRE ALARM" etc.).

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5. Shall be set on a machine-compacted pea gravel base 12-inch thick and extend 6-inches beyond box base on all sides. Provide a $\frac{3}{4}$ -inch by 10-feet copper clad ground rod through the box bottom with 9-inch projection into box, for grounding all metal parts with #10awg copper bond wire.
6. After cables have been pulled, connected, tested and inspected, seal all box joints and seal box between cover and frame with a mastic compound similar to Parmagum or Dukseal.
7. As manufactured by Jensen Precast; or Oldcastle Precast.

2.03 SWITCHES

A. General

1. Provide wiring device circuit switches totally enclosed, electrical insulating Bakelite or electrical insulating composition base, manual operator type with 277 volt 60Hz AC rating for full capacity contacts rated for incandescent lamp loads, fluorescent lamp loads and motor loads. Switch mounting-ears for screw attachment to outlet box. Switches shall be UL listed and labeled; conform to NEMA-WD1 and WD6.
2. Switch controlling (on-off) rated for all lighting loads and all non-lighting loads; switch ratings shall be 20-amp; unless indicated otherwise on Drawings.
3. Color as selected by District's Representative. Switches controlling circuits connected to emergency power shall be red.
4. All switches shall be of the same Manufacturer.
5. Where switches are mounted in multiple gang assembly and are operating at 277 volts and/or 277 volts and 120 volts or emergency/non-emergency and mounted in same outlet box, there shall be an insulating barrier installed between each switch.
6. Devices shall additionally be listed and labeled as UL-All Weather-Resistant for the following install locations:
 - a. Devices indicated on Drawings as Weather-Proof (W.P.).
 - b. Devices installed in outdoor locations
 - c. Installed in classified wet or damp area locations both indoor and outdoor.
7. Wiring devices shall be listed and labeled for connection of both "solid" and "stranded" copper circuit conductors.
8. Switches with ampere and voltage ratings different than described herein. The different rated switches shall have the same characteristics and performance as the respective described switches, except for differing ampere and voltage characteristics.

B. Switches Heavy Duty (Toggle – Type)

1. Single Pole Switches – 20 amp at 277V	<u>Manufacturer</u>	<u>Toggle Type</u>	<u>Lock Type</u>
	Hubbell	#HBL1221	#HBL1221-L
	Legrand/P&S	#20AC1	#20AC1-L
	Leviton	#1221	#1221-L
	Cooper-Arrow/Hart	#AH1221	#AH1221-L
2. Double Pole Switch – 20 amp at 277V	<u>Manufacturer</u>	<u>Toggle Type</u>	<u>Lock Type</u>
	Hubbell	#HBL1222	#HBL1222-L
	Legrand/P&S	#20AC2	#20AC2-L
	Leviton	#1222	#1222-L
	Cooper-Arrow/Hart	#AH1222	#AH1222-L

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3. Three-Way Switches – 20 amp at 277V

<u>Manufacturer</u>	<u>Toggle Type</u>	<u>Lock Type</u>
Hubbell	#HBL1223	#HBL1223
Legrand/P&S	#20AC3	#20AC3-L
Leviton	#1223	#1223-L
Cooper-Arrow/Hart	#AH1223	#AH1223-L
 4. Four-Way Switches – 20 amp at 277V

<u>Manufacturer</u>	<u>Toggle Type</u>	<u>Lock Type</u>
Hubbell	#HBL1224	#HBL1224-L
Legrand/P&S	#20AC4	#20AC4-L
Leviton	#1224	#1224-L
Cooper-Arrow/Hart	#AH1224	#AH1224-L
 5. Momentary Contact Switches – 20 amp at 277V

<u>Manufacturer</u>	<u>3-Position Regular</u>	<u>3-Position Lock</u>
Hubbell	#HBL1557	#HBL1557-L
Legrand/P&S	#1251	#1251-L
Leviton	#1251	#1251-L
Cooper-Arrow/Hart	#AH (extra)	#AH (extra)
 6. Maintained Contact Switches (Double Throw, Center Off) – 20 amp at 277V

<u>Manufacturer</u>	<u>1-Pole</u>	<u>2-Pole</u>	<u>1-Pole</u>	<u>2-Pole</u>
Legrand/P&S	#1225	#1226	#12250L	#1226-L
Hubbell	#HBL1385	#HBL1386-L	#HBL1385-L	#HBLM1386-L
Leviton	#1385	#1386		
Cooper-Arrow/Hart	#AH (extra)	#AH (extra)	#AH (extra)	#AH (extra)
 7. Pilot lights used in conjunction with circuit switches shall be LED type with red jewel.
- C. Weather-Proof (W.P.) Switches
1. Outdoor switches provide heavy-duty, tamper resistant gasketed weather proof metal, hinged door cover for each switch.
 2. Cover door shall be key locking-type or padlock-type.
- D. Other Switches, Receptacles, Devices, and Outlets
1. Special devices outlets and outlet locations shall be as indicated on the Drawings. Modify device and outlet characteristics to accommodate the actual install location conditions for each outlet.

2.04 RECEPTACLES

- A. General
1. All receptacle wiring devices in flush type outlet boxes shall be installed with a bonding jumper to connect the box to the receptacle ground terminal. Grounding through the receptacle mounting straps is not acceptable. The bonding jumper shall be sized in accordance with the branch circuit protective device as tabulated herein under "Grounding". Bonding jumper shall be attached at each outlet to the back of the box using drilled and tapped holes and washer head screws 6-32 or larger (except isolated ground receptacles). For receptacles in surface mounted outlet boxes direct metal-to-metal contact between receptacle mounting strap (if it is connected to the grounding contacts) and outlet box may be used. Receptacle mounting-ears for screw attachment to outlet box. Receptacle shall be UL listed and labeled; conform to NEMA-WD1 and WD6.

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2. All receptacles shall be same Manufacturer.
3. Receptacle color as selected by District's Representative. Receptacles connected to emergency power circuits shall be red.
4. Tamper Resistant Receptacle
 - a. Devices shall additionally be listed and labeled as tamper resistant.
 - b. The electrical receptacles shall be rated "Tamper-Resistant-Receptacle" (TR), UL-TR (RTRT). Spring loaded shutters shall automatically open-close (unblock-block) the receptacle slots, when the plug-in (cap) insertion and removal occurs.
 - c. Typical for 15-amp and 20-amp receptacles. Modify Manufacturer's catalog number description to include tamper resistant receptacle function.
5. Wiring devices shall be listed and labeled for connection of both "solid" and "stranded" copper circuit conductors.
6. Duplex convenience receptacles and 120-volt single phase branch circuits.
 - a. Duplex (convenience) receptacle, wiring device with two single receptacles with the same electrical rating, integrated into a single assembly by the Manufacturer.
 - b. 20-amp branch circuits with a single duplex convenience receptacle connection on each circuit, receptacles shall be rated for 20-amp.
 - c. 15-amp and 20-amp branch circuits with two or more duplex convenience receptacle connections each circuit, receptacle shall be rated 15-amp or 20-amp.
7. Devices shall additionally be listed and labeled as UL-All Weather-Resistant, provide weather resistant receptacles for the following install locations:
 - a. Devices indicated on Drawings as Weather-Proof (W.P.).
 - b. Devices installed in outdoor locations.
 - c. Devices installed in classified as damp or wet locations both indoor and outdoor.
 - d. All GFCI (ground-fault) receptacles all locations.
8. Receptacles with ampere and voltage ratings different than described for duplex convenience receptacles. The different rated receptacles shall have the same characteristics and performance as the respective duplex convenience receptacles, except for differing ampere and voltage characteristics.
9. Receptacles shall be GFCI type for the following locations:
 - a. located within 84-inches of a sink or hosebib shall be GFCI receptacles.
 - b. Devices installed in outdoor locations.
 - c. Devices installed in classified as damp or wet locations both indoor and outdoor.
 - d. Devices indicated on Drawings as GFCI or Weather-Proof (W.P.).

B. Duplex convenience receptacles.

1. Shall be grounding type, 120 volt and shall have two current carrying contacts and one grounding contact which are internally connected to the frame. Outlet shall accommodate standard parallel blade cap and shall be side wired. Receptacles shall be Tamper Resistant-TR, UL-TR.
2. GFCI receptacles shall be all Weather-Resistant and wet location rated. Rated 120 volt 60Hz AC, 20 amp, unless indicated otherwise on Drawings.
3. Heavy Duty Industrial Grade

<u>Manufacturer</u>	<u>NEMA 5-15R</u>	<u>NEMA 5-20R</u>	<u>NEMA 5-20R-GFCI</u>
a. Legrand/P&S	#5262	#5362	#2095HG
b. Leviton	#5262	#5362	#W7899
c. Hubbell	#CR5252	#5362	#GFR8300

d. Cooper-Arrow/Hart #AH5262 #AH5362 #WRVGF20

C. Weather Proof (W.P.) Receptacle

1. Outdoor receptacles shall be duplex convenience GFCI type rated 20-amp 120 volt 60Hz AC weatherproof, GFCI, unless indicated otherwise on Drawings. Test-reset buttons and visual pilot.
2. GFCI receptacles shall be wet location and Weather-Resistant rated weatherproof, gasketed, key locking tamper resistant, wet location.
3. Outdoor, flush mount outlet with hinged, key-locking, weather-proof cover (CEC / NEC – 406.8 compliant). As manufactured by Pass and Seymour/Legrand #4600 Series; or C.W. Cole #310 Series.
4. On exposed conduit runs, provide weatherproof ground fault circuit interrupter type GFCI receptacles installed in "FS" condulet water tight cast metal body, with weather-proof spring door type covers, gasket water tight. Door shall be key locking-type or padlock-type.

D. Other Switches, Receptacles, Devices, and Outlets.

1. Special devices, outlets and outlet locations shall be as indicated on the Drawings. Modify device and outlet characteristics to accommodate the actual install location conditions for each outlet.

2.05 PLATES

A. Metal cover plates for devices

1. Provide cover plates for every switch, receptacle, telephone, computer, television and other device outlets. All plates shall be 0.040-inch stainless steel, Type 302 alloy composed of 18% chromium and 8% nickel. Plates shall be manufactured by P&S, Hubbell, Leviton or General Electric.

2.06 VANDAL-PROOF FASTENINGS

Provide approved vandal-proof type screws, bolts, nuts where exposed to sight throughout the project. Screws for such items as switch plates, receptacle plates, fixtures, fire alarm, communications equipment, blank covers, wall and ceiling plates to be spanner head stainless steel, tamperproof type. Provide District with six screwdrivers for this type.

2.07 STRUCTURAL AND MISCELLANEOUS STEEL

Structural and Miscellaneous Steel used in connection with electrical work and located out-of-doors or in damp locations, shall be hot-dip galvanized unless otherwise specified. Included are underground pull box covers and similar electrical items. Galvanizing averages 2.0 ounce per square foot and conforms to ASTM A123.

2.08 FLASHING ASSEMBLIES

A. General

1. Flashing shall be compatible with the material being penetrated and with the pipe passing through the flashing. Coordinate with and comply with Manufacturer's recommendations, for both the flashing and the material being penetrated.
2. Provide lead metal flashing assemblies at all roof penetrations, unless recommended otherwise by Manufacturer.
3. Seal the joint between the flashing and pipe passing through the flashing with waterproofing compound.

4. Lead flashing for roof penetrations, as manufactured by: Santa Rosa Lead Products; or Semco; or Flashco.
- B. Storm Collars
 1. In addition to penetration flashing, provide a storm-collar counter-flashing for each roof penetration flashing. Shall attach to the structure of the penetration and form a water-tight "umbrella" counter flashing over the roof penetration flashing.
 2. As manufactured by: STD-Storm collars; or ASI-Storm collars.

2.09 RELAYS, CONTACTORS, AND TIMESWITCHES

- A. Individual Control Relays (HV/AC Plumbing of the Control Functions)
 1. Individual control relays shall have convertible contacts rated a minimum of 10 amp, 600 volts regardless of usage voltage. Coil voltage, number and type of contacts shall be verified and supplied to suit the specific usage as shown in the wiring diagrams and/or schedules on the electrical and mechanical Drawings. Coil control circuit shall be independently fused, sized to protect coil. Relays shall be installed on prefabricated mounting strips. Each relay shall have a surge suppressor to limit coil transient voltages. Furnished in the NEMA Type I enclosure unless indicated otherwise.
 2. The following relays are approved:

<u>Manufacturer</u>	<u>Type</u>
Cooper-Arrow/Hart	IMP
General Electric	Class CR 2811
Square D Co.	Class 8501, Type A
Westinghouse	Bul. 16-321, Type NH
Allen Bradley	Approved Equal
- B. Contactors and/or Relays
 1. Contactors and/or relays for control of lighting shall be 600 volt AC, electrically operated, mechanically held units, open type for panel mounting with number of poles and of size as indicated on the Drawings. Provide auxiliary control relay for operation of each contactor and/or relay with a 2-wire control circuit.
 2. Contactors and/or relays shall be mounted in panelboards in barriered section under separate hinged lockable doors or in contactor and/or relay cabinets as called for on the Drawings. Contactors and/or relays shall be installed on Lord sound absorbing rubber mounts.
 3. Contactors and/or relays shall be Automatic Switch Co. Bulletin #920 Series for 2-pole and 3-pole, Automatic Switch Co. Bulletin 917 Series with poles as indicated on Drawings. Coil control circuit shall be independently fused, sized to protect coil.
 4. Contactors and/or relays shall be equipped with a switch, in the proper configuration, to disconnect the control circuit controlling the coil of the respective device. Control circuit disconnect switch shall be labeled showing function of device.
- C. Time-Switches
 1. All time-switches shall have synchronous motor drive for operation on 120 or 277 volts, 60Hz, AC and shall be furnished with a 10-hour, spring-driven, reserve-power motor. Contacts shall be rated 40-amp per pole.

- a. Exterior lighting time-switches for control of individual circuits or electrically operated relays shall have astronomic dial and shall be Tork 7000ZL Series or approved equal by Paragon or Intermatic.
 - b. Interior lighting time-switches for control of individual circuits or electrically operated relays shall be Tork 7000 Series or approved equal by Paragon or Intermatic.
 - c. Time-switches for control of air conditioning or plumbing equipment shall have 7-day dial and shall be Tork WL Series or approved equal by Paragon or Intermatic.
2. All time-switches shall be mounted in separate section in top of panelboards under separate lockable door unless otherwise indicated on Drawings. Clear opening for time-switch shall be a minimum of 12-inches by 12-inches.
- D. Contactors and/or Relays/Time-Switch Cabinet
1. Contactors, relays, and/or time-switches not indicated to be mounted in electrical panels shall be mounted in a cabinet, size as required, with hinged lockable door keyed same as panelboards. Construction of cabinet shall be similar to terminal cabinets.
 2. Each contactor, relay or time-switch mounted in the contactor cabinet shall be barriered in its own compartment, and shall be installed on Lord sound absorbing mounts.
 3. Contactor cabinets shall be of the same Manufacturer as the panelboards.
 4. Where relays and/or contactors occupy the same enclosure as time-switches they shall have a clear acrylic shield installed over each relay or contactor to guard line exposed parts from accidental contact by non-authorized personnel.

2.10 DISCONNECTS (SAFETY SWITCHES)

- A. General
1. Disconnect switches shall all be rated:
 - a. 600 volt 60Hz AC for all safety switches.
 - b. NEMA Type HD, quick-make, quick-break, H.P.-rated.
 - c. Fused Class "R", in NEMA Type I enclosure, lockable.
 - d. Number of poles and amperage as indicated on the Drawings.
 2. Provide internal neutral bus, ground-lug and conductor landing lugs, size to match conductors shown on Drawings. Switch access door shall be interlocked with switch to prevent access inside switch when switch is "on" closed position.
 3. Where enclosure is indicated W.P. (Weather-Proof) switches shall be raintight NEMA Type HD and NEMA 3R enclosure, lockable.
 4. Maximum voltage, current and horsepower rating clearly marked on the switch enclosure and switches having dual element fuses shall have rating indicated on the nameplate.
 5. Switch and fuses ampere rating shall also comply with Manufacturer recommendation for the connected load.

2.11 CONCRETE WORK (ADDITIONAL REQUIREMENTS)

- A. Portland Cement
1. ASTM C33-(latest revision), Type II, Low Alkali Cement. Composed of Portland cement, coarse aggregate, fine aggregate, and water.
 - a. Concrete for use as electrical equipment footings, lighting pole bases and equipment slabs on grade, concrete shall attain minimum 28-day

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- compressive strength of 4000psi, using not less than 5.75 sacks of cement per cubic yard of wet concrete.
- b. Concrete for underground duct/conduit encasement, the minimum 28-day compressive strength shall be 2000 psi. Provide a minimum of 10-pounds of red oxide concrete coloring per yard of concrete.
 - c. Mix shall obtain a 6-inches slump, measured with standard slump cone per ASTM C143/C143M (latest revision).
- 2. Coarse Aggregate: Uniformly graded between maximum size not over 1½-inch and not less than ¾-inch and minimum Size #4, crushed rock or washed gravel. For concrete encased conduit only, maximum aggregate size shall be ½-inch.
 - 3. Fine Aggregate: Clean, natural washed sand of hard and durable particles varying from fine to particles passing ⅛-inch screen, of which at least 12% shall pass fifty mesh screens.
- B. Water: Clean and free from deleterious quantities of acids, alkalis, salts, or organic materials.
 - C. Reinforcement
 - 1. Bars: Intermediate Grade Steel conforming to ASTM A615/A615M grade 60, with pattern deformations.
 - 2. Welded Wire Fabric: ASTM A185/A185M.
 - 3. Bending: Conform to Requirements of ACI 318.
 - D. Form Material: For exposed work, use PS 1-66 "B-B Concrete Form" plywood forms, or equal. Elsewhere, forms may be plywood, metal, or 1-inch by 6-inch boards. Forms for round lighting pole bases shall be sono-tube.

2.12 WIREWAY

- A. General:
 - 1. Unobstructed lay in type, metal wireway, fittings and connectors UL listed for use as wireway and auxiliary gutter. Length, elbows and "T-S" as shown on Drawings. Minimum cross-section Size 4-inches by 4-inches, but not less than shown on the Drawings. Suitable for mounting in any position orientation.
- B. Construction:
 - 1. Minimum metal gauge shall not be less than 14 gages.
 - 2. Cover shall be hinged entire length of cover. Cover shall be held in the closed position with bolts and nuts.
 - 3. Provide spring nuts on all hardware fastener penetrations into the interior of the wireway to protect against wire insulation damage.
 - 4. The inside of 90-degree corners in the wireway shall be a 45-degree bevel.
 - 5. Grounding continuity between wireway sections and fittings shall be continuous the entire length of the wireway.
- C. Finish:
 - 1. Indoor non-raintight, rust inhibitor phosphatizing base coating and baked enamel finish, Manufacturer's standard color.
 - 2. Raintight outdoor-galvanized metal, with corrosion resistant phosphate primer and baked enamel finish, Manufacturer's standard color, NEMA 3R construction.
 - 3. All hardware shall be plated to prevent corrosion.

PART 3 EXECUTION

3.01 GROUNDING (ADDITIONAL REQUIREMENTS)

- A. Grounding shall be executed in accordance with all applicable Codes and Regulations, both of the State of California and Local Authorities Having Jurisdiction.
- B. Each pullbox or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.
- C. The Maximum Resistance to Ground shall Not Exceed 5 ohms.

3.02 OUTLET AND JUNCTION BOXES

- A. General:
 1. Accurately place boxes and securely fastens to structural members. Where outlets are shown at same location but at different mounting heights, install outlets in one vertical line. Where outlets are shown at same location and mounting height, mount outlets as close together in a horizontal row as possible. Where the outlet boxes for switches and receptacles are shown at the same location and mounting height, mount in common outlet box with barriers between devices. Provide single piece multi-gang cover plate for close mounted outlet boxes. Where switches are shown on wall adjacent to hinge side of doors, box shall be installed to clear door when door is fully opened.
 2. Flush mounted boxes shall be attached to not less than two parallel studs or structure members by means of metal supports. The supports shall span between and attach to the structure members.
 3. Boxes above accessible ceilings shall be attached to structural members. Where boxes are suspended, they shall be supported independently of conduit system by means of hanger rods and/or preformed steel channels. Boxes shall be supported independently of all piping, ductwork, equipment, ceiling hanger wires and suspended ceiling grid system.
 4. Surface mounted outlets shall be attached to concrete or masonry walls by means of expansion shields.
 5. Floor boxes shall be installed level with finish floor and within adjustable limits of floor ring. Where outlets are shown at same or adjacent location, use multi-gang boxes.
 - a. Provide cut-outs in the sub-floor assembly, to accept the recess depth of each electrical floor box. Provide added "fire-proof" applications on the bottom of each floor box location extending through the sub-floor. The "fire-proof" application shall be equal to the floor fire-assembly withstand rating.
 6. Outlet Box Horizontal and Vertical Separation: Outlet boxes and device outlet rings installed flush in walls shall be horizontally and vertically separated by not less than 24-inches (edge of box to edge of box) from device outlet boxes and rings in common wall surfaces located on the opposite (back) side of the same wall.
 - a. Where the separation cannot be maintained, provide a solid backing behind and completely enclosing each outlet box.

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- b. The backing shall extend the width of the wall cavity (i.e., between "studs" or masonry cells) behind the box and 12-inches above and below the outlet box centerline, completely enclosing the outlet box.
 - c. The backing shall consist of the following:
 - 1) $\frac{5}{8}$ -inch thick gypsum board anchored in place for "stud" wall construction.
 - 2) Solid "mortar" to completely fill the outlet box "cell" behind the box in masonry construction.
7. Provide metal outlet box for each device. Install devices in metal outlet boxes. Typical for all wiring devices including, switches, receptacles, line voltage devices, and low voltage/signal system devices.

B. Fire Wrap:

1. In fire rated walls and ceilings provide fire rated "box-wrap" around the outside of each outlet box placed in fire rated wall or ceiling. Install the fire wrap on exterior of box inside the wall or ceiling, to maintain the fire rating of wall or ceiling with the installed outlet boxes.

3.03 SWITCHES AND RECEPTACLES-DEVICES

A. General

1. Provide outlet boxes for all devices, switches, receptacles, both line-voltage and low-voltage.
2. Devices installed in wireways shall be installed flush in wireway assembly.
3. Install and screw attach devices into outlet boxes and wireways.
4. Provide ground circuit connections to all devices.
5. Provide branch circuit connections to all devices.
6. Provide testing and commissioning for proper operation and phase/ground connectors.
 - a. Test each GFCI devices after installation and circuit connection is complete.
 - b. Test all devices for correct polarity and proper electrical energization.
7. Install and adjust all coverplates to be flush and level, with correct device identification.
8. Were one or more device occurs at the proximity with other similar devices, all of the devices shall be "granged" under one common coverplate as follows:
 - a. Duplex convenience receptacles with other proximity (within 18-inches) duplex convenience receptacles.
 - b. Lighting control switches not exceeding 20-amp switch rating with other proximity (within 18-inches) similar switches.

B. Line-Voltage Plug-In Type Receptacle Installation Orientation:

1. The "ground-pin" shall face "up" at the receptacle top location (double duplex) 4-plex, individual and vertically mounted individual duplex receptacles.
2. The "neutral-blade" shall face "up" at the receptacle top location on horizontally mounted duplex receptacles.

3.04 CONCRETE WORK

A. Form:

1. Space forms properly with spreaders and securely tie together. Do not use twisted wire form ties. Keep forms wet to prevent joints from opening up before

- concrete is placed. Replace improper construction as directed. Do not use wood inside forms.
2. Build in and set all anchors, dowels, bolts, sleeves, iron frames, expansion joints and other materials required for the Electrical Work. Place all items carefully, true, straight, plumb, and even.
 3. Carefully remove all exposed forms. Cut nails and tie wires below face of concrete and fill all holes. Rubbish will not be allowed to remain in, under, or around concrete.
- B. Mixing: Use batch machine mixer of approved type. After ingredients are in mixer, mix for at least 1½-minutes.
- C. Transit Mixing: In lieu of mixing at site, transit mixing may be used if rate of delivery, haul time, mixing time, and hopper capacity is such that concrete delivered will be placed in forms within 90-minutes from time of introduction of cement and water to mixer.
- D. Placing of Concrete
1. Before placing concrete, remove wood, rubbish, vegetable matter and loose material from inside forms. Thoroughly wet down wood forms to close joints.
 2. Clean reinforcement; remove paint, loose rust, scale and foreign material. Bars with bends not called for will be rejected. Hold securely in place to prevent displacement. Lap bar splices 24-diameters, min; lap fabric one mesh min. Tie intersections, corners, splices with 16-gallon annealed wire, or as otherwise called for.
 3. Place concrete immediately after mixing. Do not use concrete that has begun to set; no tempering will be allowed. If chuting is used, avoid segregation. In placing new concrete against existing concrete, use Bonding Agent per Manufacturer's directions.
 4. Give careful and thorough attention to curing of concrete. Keep concrete and forms wet for a minimum of 10-days, after placing concrete.
- E. Concrete Finish
1. Finish of Exposed Concrete: Horizontal surfaces, steel troweled monolithic finish; vertical surfaces, smooth and free of fins, holes, projection, etc.
 2. Exposed lighting pole bases shall be filled and sack finished to a smooth finish.

3.05 WIREWAY INSTALLATION

Wireway hangers shall provide clamp type, hanger rod type, direct bolted bracket type from ceiling or walls as indicated on the Drawings and required for field installation locations. Supports shall be installed a minimum of 5-feet on center.

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SECTION 26 0533

CONDUIT AND WIRE

PART 1 GENERAL

1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the Drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
 - 1. Examine all other Sections for work related to those other Sections and required to be included as work under this Section.
 - 2. General Provisions and Requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. Submit Product Data Sheets for all wire, supports, conduit, fittings and splicing materials.
- B. Submit Material List for all conduit and conduit fittings.
- C. Submit Details and Structural Engineering Calculations for conduit support systems.

PART 2 PRODUCTS

2.01 CONDUIT

- A. General
 - 1. The interior surfaces of conduits and fittings shall be continuous and smooth, with a constant interior diameter. Conduits and conduit fittings shall provide conductor raceways of fully enclosed Circular Cross Section. The interior surfaces of conduits and fittings shall be without ridges, burrs irregularities or obstructions. Conduits and fittings of the same type shall be of the same uniform weight and thickness.
 - 2. Type of conduit, type of conduit fittings and conduit supports shall be suitable for the conditions of use and the conditions of location of installation, based on the Manufacturer's recommendations and based on applicable Codes.
 - 3. All fittings for metal conduit shall be suitable for use as a grounding means, pursuant to the applicable Code Requirements. All metal conduit and metal conduit fittings shall provide 3-second duration ground fault current carrying ratings, when installed and connected to the respective conduit, as follows:
 - a. RMC and EMT conduit fittings
 - 1) 0.5 inch through 1.5 inch conduit/fitting size – 10,000 amp RMS.
 - 2) 2.0 inch and larger conduit/fitting size – 20,000 amp RMS.
 - b. FMC and LTFMC Conduit Fittings
 - 1) 0.5 inch through 1.25-inch conduit/fitting size – 1,000-amp RMS (without external bonding jumper).
 - 2) 1.5 inch through 4.0-inch fitting size – 10,000-amp RMS with bonding jumper.

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4. Protective corrosion resistant finish for metal conduit fabricated from steel and metal conduit fittings fabricated from steel, shall be as follows:
 - a. Clean all metal surfaces (including metal threads) with acid bath "pickle" prior to coating, to remove dirt, oil and prepare surfaces for galvanizing.
 - b. Hot-dip galvanized zinc coating on all interior and exterior steel surfaces. Minimum finish zinc coating thickness shall not be less than 0.002 inches.
 - c. Threads shall be hot-dip zinc coated after machine fabrication.
 - d. Exterior metal surfaces shall be finished with clear organic polymer topcoat layer, after galvanizing.
 - e. The inner metal surfaces of conduit fittings shall be finished with a lubricating topcoat after galvanizing, to facilitate conductor pulling through the conduit/fitting.
 5. Threads for metal conduit and metal conduit fittings shall be taper-pipe-thread, National Pipe Standards (NPS) and shall comply with ANSI-B1.20.1.
 6. Metal conduit termination connector fittings shall be provided with a Manufacturer installed, insulating throat bushing inside the fitting. The bushing shall protect the wire conductor insulation from cutting, nicks and abrasion during conductor installation and electrical load "cycling" after installation is complete. The bushing shall comply with UL 94V-0 flammability.
 7. Provide conduit bonding/grounding jumper from metal enclosures with "concentric ring" knockouts, to positively ground/bond each respective conduit(s) to the metal enclosure.
 8. Metal conduit fittings connecting to PVC coated metal conduit shall be PVC coated to match the conduit.
 9. The conduit and fittings shall be watertight and airtight without cracks and pin-holes.
- B. Rigid Metal Conduit (RMC)
1. Rigid metal, round tubing, machine threaded at both ends.
 - a. The conduit and conduit fittings shall comply with the Requirements for an equipment grounding conductor, pursuant to applicable Codes.
 2. RMC raceway types shall be as follows:
 - a. Rigid Galvanized Steel conduit (RGS), minimum yield strength shall be 35,000 PSI. Shall comply with NEMA Standard 5-19 (latest revision); ANSI C80.1 and ANSI-C80.4 (latest revision); UL 514-B and UL 6 (latest revisions); National Pipe Standard Specification (latest revision).
 - b. Intermediate Steel Conduit (IMC). Shall comply with NEMA Standard 5-19 (latest revision) ANSI-C80.6 (latest revision); UL 2142 (latest revision).
 3. RMC fittings:
 - a. Fittings shall be compatible with RGS and IMC.
 - b. Fittings shall be rated "liquid tight".
 - c. Fittings imbedded in concrete shall be rated "liquid tight" and "concrete tight".
 - d. Connectors and couplings for terminating, connecting and coupling to RMC conduit shall be threaded metal.
 - e. Fittings shall comply with ANSI C80.4 and ANSI C33-84 (latest revision); NEMA FB1 (latest revision); UL 514 (latest revision).
 - f. Conduit seal fittings:
 - 1) Conduit seals shall prevent the passage of gasses, liquids and vapors past the location of the seal installation in the conduit.
 - 2) Conduit seals shall be suitable for installation in both vertical and horizontal conduit locations.

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- 3) Conduit seals shall be visible and accessible for inspection after installation is complete.
 - 4) Conduit seals shall be rated for the following locations:
 - a) Wet locations
 - b) Classified hazardous location materials NEC Class 1 Division 1.
 - c) Temperature ranges from 0 minus 20 degrees centigrade through 90 degrees centigrade.
 - 5) Conduit seals, sealing compound and sealing compound dam shall be the products of the same Manufacturer.
4. RMC fittings as manufactured by:
- a. For threaded enclosure, termination connection.
 - 1) Thomas & Betts - 106 Series bonding locknut, 5302 Series sealing ring with stainless steel retainer.
 - b. For non-threaded enclosure, termination connector.
 - 1) Thomas & Betts - 370 Series watertight threaded sealing hub, 106 Series threaded bonding lock nut, Sta-Con Series enclosure bonding jumper and 3870 Series threaded ground bushing.
 - 2) Emerson-OZ/Gedney-CHMT/CHT watertight threaded hub with bonding locknut and GH50G Series enclosure bonding jumper.
 - c. For RMC to RMC conduit-to-conduit coupling
 - 1) Thomas & Betts/Erickson - 674 (threaded) Series
 - 2) Emerson-OZ/Gedney Type TPC (threaded) Series
 - 3) Threaded RMC conduit couplings, product of the same Manufacturer as the RMC conduit.
 - d. For RMC Conduit Seals
 - 1) Emerson-OZ/Gedney-EYA and EYAM (threaded) Series
 - 2) Appleton-EYF and EYM (threaded) Series
- C. Electrical Metallic Tubing (EMT)
1. Rigid metal round tubing, "thin wall" steel construction, with non-threaded ends.
 - a. The conduit and conduit fittings shall comply with the Requirements for an equipment grounding conductor pursuant to applicable codes.
 - b. The conduit shall be watertight and airtight without cracks and pinholes.
 2. EMT shall be allowed for conduit size ranges from 0.5-inch through 4.0-inches.
 3. Comply with ANSI C80.3, C80.4, and ANSI C33.98 (latest revisions); UL 594 and UL 797 (latest revisions); CEC Section 12500 (latest revision).
 4. EMT fittings:
 - a. Connectors and couplings for terminating, connecting and coupling to EMT conduit shall be non-threaded steel fabrication.
 - b. EMT termination connector fittings shall be as follows:
 - 1) Set screw type "concrete tight" when installed in dry interior locations.
 - 2) Compression types "raintight" and "concrete tight" when installed in wet or damp locations, outdoors and in concrete or masonry construction.
 - c. Fittings shall comply with ANSI C33.84 (latest revision); UL 514 (latest revision); NEMA FB-1.
 5. EMT fittings as manufactured by:
 - a. For threaded and non-threaded enclosure, termination connector:
 - 1) Thomas & Betts-TC721A (set screw type) Series (with locknuts).
 - 2) Emerson-OZ/Gedney-TC500I (set screw type) Series (with locknuts).

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- 3) Thomas & Betts-5123 (compression type) Series (with two lock-nuts).
 - 4) Emerson-OZ/Gedney-TC600I (compression type) Series (with lock-nut).
 - 5) Thomas & Betts-4240 (compression type) Series (90 degree angle with locknut).
 - 6) Emerson-OZ/Gedney-TWL (compression type) Series (90 degree angle with locknut).
 - b. For EMT to EMT conduit-to-conduit coupling:
 - 1) Thomas & Betts-TK121A (set screw type) Series (with locknut).
 - 2) Emerson-OZ/Gedney-5000 (set screw type) Series (with locknut).
 - 3) Thomas & Betts-5120 (compression type) Series.
 - 4) Emerson-OZ/Gedney-TC600 (compression type) Series.
 - c. For EMT to RMC conduit to conduit combination coupling:
 - 1) Thomas & Betts-HT221 (set screw type) Series.
 - 2) Emerson-OZ/Gedney-ESR (set screw type) Series.
 - 3) Thomas & Betts-530 (compression type) Series.
 - 4) Emerson-OZ/Gedney-ETR (compression type) Series.
- D. Flexible Metal Conduit (FMC)
1. Round flexible conduit, fabricated from a single continuous steel strip. The steel shall be factory formed into continuous interlocking convolutions to form a complete lock between steel strips and provide raceway flexibility.
 2. Metal to metal grounding contact shall be maintained throughout the length of the FMC conduit.
 3. FMC shall be allowed for conduit size ranges from 0.5 inch through 4.0-inches.
 4. FMC shall comply with ANSI-C.33.84 and ANSI C33.92; NEMA FB-1; CEC 12-1100.
 5. FMC Fittings
 - a. FMC fittings shall be malleable iron construction or steel construction.
 - b. Fitting shall automatically cause the FMC raceway throat opening to be centered with respect to the fitting throat opening.
 - c. Straight and angled connector termination fittings shall be threaded on one end and shall include a threaded locknut, suitable for connection to threaded and unthreaded enclosures.
 - d. The attachment of the fittings to FMC shall be angled saddle type, to engage and interlock with the FMC spiral groove, and shall be unaffected by vibration. Direct bearing screw type fittings shall not be used.
 - e. Direct FMC conduit-to-FMC conduit coupling of FMC shall not be permitted.
 - f. Shall comply with ANSI C33.9, and ANSI C33.92 (latest revision); NEMA FB1 (latest revision); UL 514.
 6. FMC fittings as manufactured by:

a. Straight Termination Connectors	45 and 90 Degree Angle Connectors
Thomas & Betts-3110 Series	Thomas & Betts-3130 Series
(with locknut)	(with locknut)
b. FMC to EMT conduit combination coupling:	Thomas & Betts 503TB Series.
- E. Liquid Tight Flexible Metal Conduit (LTFMC)
1. The metal conduit core of LTFMC shall comply with the same Requirements as FMC conduit, with the addition of a thermoplastic exterior flexible jacket over the metal core.

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2. The exterior jacket shall be positively locked to the metal core to prevent jacket "sleevng".
3. The LTFMC shall be rated for installation and operating service temperatures of between minus 20 degrees centigrade through plus 90 degrees centigrade.
4. The LTFMC jacket shall be suitable for continuous exposure to sunlight, rainwater, water vapor, mineral oils and liquid solvents, without penetrating into the conduit and without deteriorating the jacket.
5. LTFMC sizes from 0.5-inch through 1.25-inch shall include an additional internal ground conductor, fabricated by the Manufacturer, as an integral part of the conduit core.
6. Direct LTFMC conduit-to-LTFMC conduit coupling of LTFMC shall not be permitted.
7. LTFMC shall be allowed for conduit size ranges from 0.5-inch through 4.0-inches.
8. In addition to the Requirements for FMC conduit, LTFMC shall also comply with ANSI C-33.84 (latest revision); NEMA-FB1 (latest revision); CEC 12-1400 (latest revision).
9. LTFMC fittings
 - a. Fittings shall include an external mechanical ground/bond wire connector.
 - b. The attachment of the fitting to LTFMC shall be threaded compression type onto the conduit core with locknut and liquid tight jacket compression seal. The fitting shall automatically prevent "sleevng" of the jacket.
 - c. Straight and angled termination connector fittings shall be threaded on one end and shall include locknut suitable for connection to threaded and unthreaded enclosures.
10. LTFMC fittings as manufactured by:
 - a. Termination connector fittings:

Straight	45 and 90 Degree Angle Connectors
1) Thomas & Betts-5331 GR Series	Thomas & Betts-5341GR & 5351 GR Series.
2) Appleton-STB & STN-L Series for use with Performed "knockouts".	Appleton-STB-L Series; STN-L Series for use with preformed "knockouts".
3) Emerson- OZ/Gedney-4Q Series	Emerson-OZ/Gedney-4Q Series
 - b. LTFMC to RMC conduit to conduit combination coupling fittings:
 - 1) Thomas & Betts-5271 GR Series.
 - 2) Emerson-OZ/Gedney-4Q Series

F. Rigid Non Metallic Conduit (RNMC)

1. General
 - a. Conduit and fittings shall be 90 degree centigrade conductor rated. Fabricated from homogeneous material, free from visible cracks, holes or foreign inclusions, with integral "end-bell". The conduit and conduit fittings shall be watertight and airtight.
 - b. Conduit, conduit fittings and conduit fitting assembly "solvent cement" shall all be the product of the same Manufacturer. Conduit fittings shall be solvent cement welded watertight.
 - c. Conduit and fittings shall be identified with legible markings showing ratings, size and Manufacturers name.
 - d. RNMC and fitting shall be corrosion resistant, watertight.
 - e. Conduit shall be suitable for conductor operating temperatures from minus 20 degrees centigrade to 90 degrees centigrade.

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- f. RNMC shall comply with NEMA TC-2 (PVC 40 conduit, latest revision) NEMA TC-6 (EB conduit latest revision) and NEMA TC-3 (fittings, latest revision); UL 514 and UL 651 (latest revision).
 2. Polyvinyl Chloride (PVC)-RNMC
 - a. PVC-Schedule 40 heavy wall construction.
 - b. PVC-Schedule 80 extra heavy wall construction.
 - c. PVC-Type EB.
 3. RNMC fittings connecting to metallic raceways shall be provided with a ground/bond jumper connection.
- G. Combi-Duct
1. Rigid nonmetallic conduit combining a continuous linear outer raceway (duct) with factory installed (inside the outer duct) multiple, segregated inner raceway (ducts). Rigid, Schedule 40 PVC construction. Shall be modular lengths of 20-feet for each duct segment.
 2. The conduit shall be suitable for use with signal/telecommunications, fiber optic, telephone and computer/data circuits, operating at 100-volts or less, UL listed and labeled.
 3. Outer Duct, outer enclosing Schedule-40 PVC duct size. The outer enclosing duct shall be 4.2-inches inside nominal duct diameter and 4.5-inches outer duct nominal diameter.
 4. Inner-ducts (contained inside the enclosing outer duct), non-metallic SDR-19 or Type-C/CAO-8546:
 - a. Triple Combi-Duct
 - a. Quantity of three continuous round rigid inner linear ducts, nominal size inside diameter 1.5-inch for each inner duct.
 - b. Quad Combi-Duct
 - b. Quantity of four continuous round rigid inner linear ducts, nominal size inside diameter 1.19-inch for each inner duct.
5. Manufacturer's standard bends and offsets, minimum 72-inches radius.
6. Combi-duct and combi-duct fittings shall be airtight and watertight. Approved for direct burial in earth and approved for encasement in concrete.
7. As manufactured by Carlon # Multi-Guard/Multi-Cell Series; American Pipe and Plastic (AMTEL) #Multi-Bore Series; or equal.
- H. Expansion Joint, Deflection Joint and Seismic Joint Conduit Fittings
1. Expansion Conduit Fitting - Fitting shall provide for a minimum of 2-inches straight line movement between two connecting conduits in each direction (total 4-inches conduit expansion and Contraction) parallel to the respective conduit lengths. Fitting shall be watertight.
 2. Deflection Conduit Fitting - Fitting shall provide for a minimum of 30 degrees angular deflection movement ("Shear" deflection) between two connecting conduits, in any direction perpendicular to the length of the respective conduits. Fitting shall be watertight.
 3. Combination Expansion/Deflection Conduit Fitting - Fitting shall provide the combined "expansion" and "deflection" movement capacity between two connecting conduits as described for separate "expansion" and "Deflection" conduit fittings. Fitting shall be approved for installation concealed in both masonry/concrete construction and exposed non-masonry/concrete construction. Fitting shall be watertight.
 4. Fittings shall comply with UL.

5. Fittings as manufactured by:
 - a. Conduit expansion fittings exposed or concealed locations as manufactured by:
 - 1) Emerson-OZ/Gedney – AXB-8 Series for RMC conduit.
 - 2) Emerson-OZ/Gedney - TX Series for EMT conduit.
 - 3) Appleton – AXB or XJ8 Series for RMC conduit and EMT conduits. Provide RMC to EMT combination conduit coupling fittings for each end of the expansion fitting.
 - b. Combination expansion/deflection conduit fittings exposed or concealed conduit locations as manufactured by:
 - 1) Emerson-OZ/Gedney - AXDX Series for RMC conduit.
 - 2) Emerson-OZ/Gedney - AXDX Series for EMT conduit.
 - 3) Appleton-DX Series for RMC conduit.
 - 4) Provide RMC to EMT combination conduit coupling fittings for each end of the expansion/deflection fitting.
 - c. Conduit expansion/deflection fittings for FMC and LTFMC conduit.
 - 1) Provide a minimum of 12-inches of "slack" LTFMC in each FMC or LTFMC conduit at building and structure seismic or expansion joint crossings.
 - 2) Note: Each FMC "slack" expansion/deflection location, shall be considered as not less than a 90 degree conduit bend location, for compliance with the maximum quantity of conduit bends allowed in a raceway.
 6. Conduit fitting bonding jumper:
 - a. The grounding/bonding path of metal conduit shall be maintained by the fitting.
 - b. Provide a bonding jumper at each expansion, deflection and combination expansion deflection conduit fitting.
 - c. The jumper shall be a bare flexible copper "braid". The copper braid electrical current carrying capacity shall be equal to the metal conduit.
 - d. Provide a factory terminated ground clamp on each end of the braid with adjusting steel conduit grounding clamps and connect to each respective conduit end.
 - e. The jumper braid length shall be 8-inches longer than the respective conduit fitting.
 - f. Bonding jumper for FMC and EMT fittings as manufactured by:
 - 1) Emerson-OZ/Gedney – BJ and BJE Series
 - 2) Appleton – BJ/XJ Series
- I. Conduit Bodies Conduit Fitting
1. Conduit bodies shall provide conductor access with a removable conduit body cover and wiring area enclosed in metal housing. The conduit body shall facilitate pulling conductors.
 2. In-line form "C" conduit bodies shall be prohibited.
 3. The interior space "length" of 90 degree "elbow" conduit bodies shall not be less than six times the diameter size of the largest conduit connecting to the conduit body.
 4. Conduit body covers shall be removable, gasketed; watertight "domed" metal covers "Mogul-Type" with threaded screw attachment to the conduit body.
 5. Lubricated, reusable, wire roller guards inside the conduit body shall protect wire from insulation damage during wire "pulling".
 6. Conduit body fittings shall comply with UL 514.

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7. Conduit bodies as manufactured by:
 - a. For RMC Conduit
 - 1) Hubbell/Killark – LB/Mogul (90-degree elbow) Series – threaded body.
 - 2) Emerson-OZ/Gedney - LB 6X/Mogul (90 degree elbow) Series - threaded body.
 - 3) Appleton – NEC6X-LB/Mogul (90 degree elbow) Series - threaded body.
 - b. For EMT Conduit
 - 1) Same as for RMC conduit. Provide EMT to RMC conduit combination coupling fitting for each outlet body connection.

2.02 PVC COATING

- A. PVC coatings shall be provided as described for specified metal products.
- B. PVC coating shall be factory applied, to comply with NEMA-RN1 and 5-19.
- C. The adhesion of the PVC coating to the coated metal shall exceed the strength of the coating itself, based on 0.5-inch “strip-pull” test.
- D. Uniform coating thickness shall be continuous without “breaks” or “pinholes” and shall not be less than the following:
 1. Exterior metal surfaces, 40-millimeter coating thickness.
 2. Interior metal surfaces, 10-millimeter PVC or urethane coating thickness (i.e. interior of conduits, interior of conduit fittings etc.).

2.03 CONDUIT SUPPORTS

- A. General
 1. Conduit Supports, hangers and fasteners for metal conduit shall be steel, hot dip zinc galvanized.
 2. Conduit supports, hangers and fasteners for PVC coated conduit shall be PVC coated to match the conduit PVC coating.
 3. Threaded hardware shall be continuous, free running threads.
 4. Conduit support systems, including support channels, pipe clamps, braces, anchors, hardware, fasteners, shall be sized to support the full capacity circuit conductors weight, plus the installed conduit weight, plus the conduit fitting weight and support hardware weight, plus a 300% additional weight capacity safety factor.
 5. Provide lock washer at each “bolted”/threaded connection.
 6. Conduit supports, fasteners, channels, braces, hardware, anchors, pipe clamps, and hangers as manufactured by Unistrut or Kindorf.
 7. Supports shall be free of “BURRS” and sharp edges.
 8. Metal supports cut in the field shall be zinc galvanized after cutting to prevent rust.
- B. Conduit Hangers
 1. Threaded steel hanger rods.
 - a. Hanger rods smaller than 0.375-inches in diameter shall not be used for support of individual conduits.
 - b. Hanger rods smaller than 0.5-inches in diameter shall not be used for support of multiple conduits.

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2. Conduit hanger wires shall be not less than 12-gauge steel.
 3. Conduit hangers shall attach to structure fasteners with steel "Clevis" or "Swing" hangers and shall provide a minimum of 45 degrees of angular movement in any direction at the point of the conduit hanger attachment to the structure fasteners.
 4. Conduits individually suspended by conduit hangers shall fasten to the respective hangers with "Clevis" type pipe hangers. The pipe hangers shall be steel, adjustable to fit conduit size and shall completely enclose the conduit circumference.
- C. Conduit Support Channels
1. "C" channels shall be factory preformed with a minimum 12 gauge thickness metal. The channel shall be factory "punched" with regularly spaced slotted holes for fastener attachments along the length of the channel.
 2. The "C" channel shall not deflect more than 0.1 inch between channel supports at maximum installed design load, including required safety factor.
 3. Channels shall comply with ANSI-1008 (latest revision) and ASTM-A569 latest revision).
 4. Channels shall provide "turned lips" at longitudinal edges to hold (lock-in) fasteners.
 5. Conduit support channels suspended from conduit hangers shall attach to conduit hangers with treaded connections. Provide a minimum of two hangers (trapeze style) connected to each channel.
 6. Non-suspended conduit support channels shall connect to structure fasteners with threaded connectors.
- D. Fasteners, Seismic Earthquake Rated
1. Channel fasteners:
 - a. Channel fasteners shall "prelocate" and lock into the channel "turned lips" and channel "walls".
 - b. A separate metal strap shall "tie" each conduit to each channel with conduit channel fasteners.
 2. Structure fasteners:
 - a. Structure fasteners for wall and floor mounted conduit attachments shall attach to existing masonry and concrete structures with structure fasteners using drilled, mechanical, expansion shield anchors.
 - b. Structure fasteners for wall and floor mounted conduit attachments shall attach to new masonry and concrete structures with structure fasteners using steel threaded inserts precast into the structures.
 - c. Structure fasteners shall center the support load above or below the beam flanges and reduce torsion-rotation forces exerted on the structural beam. Attach to steel structural members with "swing-beam clamps", with set-locking screw structure fasteners.
 - 1) Beam clamps shall include integral safety rod, strap or "J"-hook to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
 - 2) Or double-ended beam clamp to secure the attachment clamp to the beam flanges on both sides of the beam, with integral hanger rod attachment.
 - d. Structure fasteners for wall and floor mounted conduit attachments shall attach to wood structural members with flush "through-bolted" wood beam / wood framing stud structure fasteners.

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- e. Structure fasteners for wall mounted conduit attachments shall attach to steel framing studs and steel structural elements with spot welded steel structure fasteners or drilled and bolted structure fasteners.

- E. Brace Connectors
 1. Provide lateral brace connectors to resist horizontal, lateral and vertical movement of suspended conduits during seismic earthquakes.
 2. The braces shall connect from each conduit support, attach as close to the conduit as possible, and attach to fixed rigid, non-suspended building "main" structural elements with fixed anchoring.
 3. Brace attachment connectors and fasteners shall be rigid preformed steel channels or flexible #10 gauge steel hanger wire.
 4. Connect and attach the brace connectors to fixed structural elements in the same manner as conduit support hangers. The connection of braces to structural elements shall be independent of the conduit support hanger structure fasteners.

2.04 ELECTRICAL POWER WIRE AND CABLE

- A. General
 1. All wire and cable shall be single-conductor, annealed copper, insulated 600 volt, #12AWG minimum unless specifically noted otherwise on the Drawings.
 2. Conductors #10AWG and smaller shall be solid. Conductors #8AWG and larger shall be stranded.
 3. Insulation of conductor connected to circuit protection devices required to be "100%" rated, shall be 90 degree centigrade rated insulation.
 4. Insulation of conductors installed outdoors, on grade or underground, insulation shall be rated for wet locations.
 5. Insulation of conductors installed outdoors, installed exposed to the sun, installed in exposed conduits, insulation shall be rated for high-temperature 90 degrees centi-grade.
 6. Insulation of branch circuit conducts installed in light fixtures, insulation shall be rated for 90 degrees centigrade.
 7. Conductor exposed to oil, insulation and jacket shall be oil resistant, complying with "Oil Resistant-1" and "Oil Resistant-2" UL 83.

- B. Conductor Insulation
 1. 600 Volt AC and/or DC insulated conductors installed entirely inside conduits, or enclosed inside wireways, or enclosed inside raceways, insulation shall be rated as follows.
 2. Indoor above Grade locations either concealed or exposed.
 - a. Dual rated THHN and THWN
 - b. Individually rated THHN-2
 - c. Individually rated THWN-2
 - d. XHHW-2
 3. Outdoor above Grade either concealed or exposed.
 - a. XHHW-2
 - b. THWN-2
 - c. THW-2
 4. Outdoor below Grade or outdoor on Grade.
 - a. XHHW-2
 - b. THWN-2
 - c. THW-2

5. All other enclosed raceway locations not described above.
 - a. XHHW-2
 - b. THWN-2
 - c. THW-2
- C. Insulation Color Coding and Identification
 1. The following color code for branch circuits:
 - a. Neutral . . . White (Tape feeder neutrals with white tape near connections)
 - b. Normal Power

<u>120/208 Volt</u>	<u>480/277 Volt</u>
Ground Green	Ground Green
Phase A Black	Phase A Brown
Phase B Red	Phase B Orange
Phase C Blue	Phase C Yellow
 - c. Isolated ground insulation shall be green with a longitudinal yellow stripe.
 - d. Emergency power same insulation color as normal power except as follows:

<u>120/208 Volt</u>	Provide an additional continuous stripe on each conductor insulation, orange or yellow, except ground
<u>480/277 Volt</u>	Provide an additional continuous stripe on each conductor insulation blue or black, except ground
 2. When individual neutral conductors are shown/required for each branch circuit, the color code for the neutral conductors shall be as follows:
 - a. 120/208 volt; Phase A - White with Black stripe; Phase B - White with Red stripe; Phase C - White with Blue stripe.
 - b. 277/480 volt; Phase A - White with Brown stripe; Phase B - White with Orange stripe; Phase C - White with Yellow stripe.
 3. Feeders identified as to phase or leg in each, switchboard, switchgear, panelboard, junction and termination location with printed identifying tape/ tags.
 4. Fire alarm conductors: Use 600-volt, type THHN-2/THWN-2 conductors and color-coded per Equipment Manufacturer's recommendations and approved and listed for use on fire alarm systems by the State Fire Marshal and AHJ.
 5. Color coding for HVAC mechanical and plumbing control wiring shall be an agreed upon color code between the Mechanical/Plumbing Contractor and the Electrical Contractor and color code shall be submitted to the Owner's Representative in writing for approval prior to installation.
- D. Panel Feeders Copper Only.

2.05 CHEMICAL GROUND ROD

- A. General
 1. Self-contained ground rod(s) using chemically enhanced grounding shall be provided where specifically indicated on the Drawings. As manufactured by Lyncole XIT Grounding Systems, 22412 South Normandie Avenue, Torrance, CA. Telephone #(800) 962-2610; or Superior Grounding Systems, Irwindale, CA. Telephone #(800) 747-7925; or ERICO – Eritech Chemical Ground Electrode.

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2. The ground rod shall operate from changes in atmospheric pressure pumping air through the ground rod, hygroscopically extracting moisture from the air to activate the ground electrolytic chemicals and improve the ground rod performance.
 3. Ground rod system shall be UL-467 listed.
 4. Ground rod system shall be 100% self-activating, sealed and maintenance free. The addition of chemical or water solutions shall not be required.
- B. Ground Rod
1. Ground rod shall consist of a 2-inches nominal diameter hollow, copper tube. The tube shall be permanently capped on the top and bottom. Air breather holes shall be provided in the top of tube. Drainage holes shall be provided in the bottom and sides of the tube for electrolyte drainage into the surrounding soil.
 2. The ground rod shall be chemically filled at the factory with environmentally non-hazardous water-soluble metallic salts to enhance electrical grounding performance.
 3. Ground rod shall be a minimum of 10-feet long for straight (vertical) installation; or "L" shape minimum 20-feet long for horizontal installation.
 4. Ground wire clamping "U-Bolt" with pressure plate on the top end of the tube sized for 1#2 through 500 MCM AWG ground electrode conductor connection, and stranded 4/0AWG copper pigtail exothermically welded to the side of rod for ground electrode conductor connection.
- C. Ground Box
1. Precast concrete box with slots for conduit entrances. Approximately 10-inch diameter by 12-inches high. Cast iron grate flush cover with "Breather" slots XIT Box #XB-12.
- D. Backfill Material
1. Natural volcanic, non-corrosive Bentonite Clay backfill material.
 2. Shall absorb water at a minimum of thirteen times its dry volume or approximately 14 gallons for 50 pounds of clay.
 3. PH value 8-10 with maximum resistivity of 2.5 OHMS-M at 300% moisture content by weight.

2.06 CABLE RACKS

- A. Cable Racks, installed on the vertical walls of the structure, including hooks and porcelain insulator cable cradles, shall be sufficient to accommodate the cables and splices.
- B. Vertical Racks shall be installed on all walls of the structure a minimum of 24-inches on center within 6-inches of floor and top of wall. A rack shall be installed within 18-inches of each corner of each wall. Additional racks spaced equally on each wall shall be installed; spacing between vertical wall racks shall not exceed 24-inches.
1. Wall racks shall be slotted to accept removable hooks and lock hooks into place.
 2. Non-metallic, 50% (minimum) glass reinforced nylon or non-metallic material of the same characteristics.

3. The installed cable racks, cable support hooks with arms and wall anchor bolts shall support the following minimum loads for each hook/arm, with a 200% minimum safety factor. Based on multiple hook/arms located not less than 9-inches on center along the entire vertical length of the support rack:

<u>Hook/Arm Length</u>	<u>Min. Weight Each Hook/Arm Supported</u>	<u>Max. Allowable Hook/Arm Deflection</u>
a. 8-inches	450 pounds	0.25-inch
b. 14-inches	350 pounds	0.37-inch
c. 20-inches	250 pounds	0.37-inch

(Based on load concentrated 1-inch from the end of each hook/arm.)

4. Racks shall be bolted to the precast and cast-in place structure walls, within 3-inches of each rack end and not less than 9-inches on center. Provide cast-in place or after-set drilled expansion concrete anchors.

PART 3 EXECUTION

3.01 TRENCHING, FOOTINGS, SLEEVES

- A. Provide trenching, concrete encasement of conduits, backfilling, and compaction for the underground electrical work, in accordance with applicable Sections of this Specification.
- B. Provide footings for all post and/or pole-mounted lighting fixtures: concrete shall conform to the applicable Sections of this Specification.
- C. Sleeves
 1. Provide sleeves for raceways, conduit and wire/cables passing through the following construction elements:
 - a. Concrete and masonry foundations, floors, walls and slabs.
 - b. Gypsum, Lath, and plaster walls and ceilings.
 - c. Building structures (i.e., foundations, walls, floors, ceilings, beams, and roofs) with a fire rating exceeding 20-minutes.
 2. Sleeves shall extend 1.5-inch above and below floors, except under floor standing electrical equipment. Sleeves shall be flush with wall ceiling foundations and partitions exposed to public view and extend approximately 0.5-inch past penetration in fire rated construction. Sleeves shall be installed at exact penetration locations and angles to accommodate wire/cable, raceway and conduit routings.
 3. Joists, girders, beams, columns or reinforcing steel shall not be cut or weakened. Where construction necessitates the routing of conduit or raceways through structural members, framing or footings, written permission to make such installation shall first be obtained from the District's Representative. Such permission will not be granted, however, if any other method of installation is possible.
 4. The layout and design of raceways and conduits located in or routed through masonry or reinforced beams or the District's Representative shall review walls before any work is performed. All sleeving shall be accomplished according to the instructions of the District's Representative and shall be accepted before any concrete is poured.
 5. Sleeves, raceways and conduit shall be located to clear steel reinforcing bars in beams. Reinforcing bars in walls shall be offset to clear piping and sleeves.

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6. Provide a continuous clearance between the inside of a sleeve and exterior of wire/cables, conduits and raceways passing through the sleeve not less than the following:
 - a. 0.5-inch clearance except as required otherwise.
 - b. 1.0-inch clearance through outside walls below grade.
 - c. 3.0-inch clearance through seismic joints.
7. Sleeves set in fire rated construction shall be caulked between sleeve and building structure, additionally sleeves shall be caulked between the sleeve and the wire/cables, conduits/raceways passing through the sleeve. The caulking shall be a fireproof sealant, equal to the fire rating and temperature being penetrated. Clearance between components inside of sleeve and exterior of components passing through sleeve and between components inside the sleeve shall comply with Fireproof Sealant Manufacturer's recommendations.
8. Sleeve material:
 - a. In floor construction: Schedule 40 black steel pipe, with upper surface to be sealed watertight.
 - b. In concrete or masonry walls roofs or ceilings: Schedule 40 black steel pipe. When installed in roofs or outside walls, seal outer surface watertight.
 - c. In fire rated construction; 24 gauge galvanized iron or steel.
 - d. Sleeves through waterproof membranes: Cast iron or Schedule 40 steel with flashing clamp device and corrosion resistant clamping bolts. Caulk space between pipe and sleeve and surfaces between sleeve and conduits sealed watertight.

3.02 GROUNDING

- A. Grounding shall be executed in accordance with all applicable Codes and Regulations, both of the State and Local Authorities Having Jurisdiction.
- B. Where nonmetallic conduit is used in the distribution system, the Contractor shall install the proper sized copper ground wire in the conduit with the feeder for use as an equipment ground. The electrical metallic raceway system shall be grounded to this ground wire.
- C. The maximum ground/bond resistance to the grounding electrode shall not exceed 1 ohms from any location in the electrical system. The maximum ground resistance of the grounding electrode to earth shall not exceed 5 ohms.
- D. Ground/Bond Conductors
 1. Provide an additional, dedicated, green insulation equipment ground/bond wire inside each conduit type and raceway as follows. Size the ground/bond conductors to comply with CEC/NEC Requirements. The metal conduit or raceway shall not be permitted to serve (function) as the only (exclusive) electrical ground return path:
 - a. All types of nonmetallic conduit and all types of non-metallic raceways including but not limited to: RNMC - Rigid Nonmetallic Conduit.
 - b. FMC - Flexible Metal Conduit.
 - c. LTFMC - Liquid Tight Flexible Metal Conduit.
 - d. Metal and non-metal raceways.
 - e. RMC - Rigid Metal Conduit.
 - f. EMT - Electrical Metal Tubing.

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2. The equipment ground/bond wire shall be continuous from the electrical circuit source point of origin to the electrical circuit end termination utilization point as follows:
 - a. Every conduit and raceway path containing any length of the above identified conduits or raceway.
 - b. Every conduit path and raceway path connected to any length of the above-identified conduits and raceways.
 3. The equipment ground/bond wire shall be sized as follows, but in no case smaller than indicated on the Drawings. Install equipment ground/bond wire in each conduit/raceway, with the respective phase conductors:
 - a. Feeder, Subfeeders & Branch Circuit Protection Min. Equipment Ground Wire Size

15 amp	#12
20 amp	#12
30 to 60 amp	#10
70 to 100 amp	#8
101 to 200 amp	#6
201 to 400 amp	#2
401 to 600 amp	#1
801 to 1000 amp	2/0
1001 to 1200 amp	3/0
1201 to 1600 amp	4/0
1601 to 2000 amp	250 MCM
2001 to 2500 amp	350 MCM
2501 to 4000 amp	500 MCM
 4. Isolated grounds - Raceways containing branch circuit or feeder phase conductors connected to panelboards equipment, or receptacles with isolated grounds or isolated ground bus shall contain a dedicated insulated ground conductor connected to the isolated ground system only. The isolated ground conductor shall be continuous the length of the raceways and connected only to the isolated ground terminals in addition to and independent of the equipment bonding/ground conductor. The isolated ground conductor shall be sized as indicated above, for equipment ground/bond wire.
 5. Splices in ground/bond wires shall be permitted only at the following locations:
 - a. Ground buses with listed and approved ground lugs.
 - b. Where exothermic welded ground/bond wire splices are provided.
 6. Provide ground/bond wire jumpers for conduit fittings with ground lugs, expansion and deflection conduit fittings at conduit fittings connecting between metallic and non-metallic raceways and to bond metal enclosures to conduit fittings with ground lugs.
- E. Where conductors are run in parallel in multiple raceways, the grounding conductor shall be run in parallel. Each parallel equipment-grounding conductor shall be sized on the basis of the ampere rating of the overcurrent device protecting the circuit conductors in the raceway. When conductors are adjusted in size to compensate for voltage drop, grounding conductors, where required, shall be adjusted proportionately in size.
- F. Ground conductors for branch circuit wiring shall be attached at each outlet to the back of the box using drilled and tapped holes and washer head screws, 6-32 or larger.

- G. Each panelboard, switchboard, pull box or any other enclosure in which several ground wires are terminated shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.

3.03 CONDUIT

- A. General
1. The sizes of the conduits for the various circuits shall be as indicated on the Drawings, but not less than the conduit size required by Code for the size and quantity of conductors to be installed in the conduit.
 2. Conduits shall be installed concealed from view. Install conduits concealed in walls, concealed below floors and concealed above ceilings, except as specifically noted otherwise.
 - a. Conduits shall not be installed in concrete floors.
 3. The following systems shall be considered as circuits 100 volts and less, all other circuits shall be considered to be over 100-volts (power circuits) unless specifically noted otherwise: Fire alarm, energy management control, telephone, public address, data, computer, television, intercom, intrusion alarm and nurse call.
 4. Conduits shall be provided complete with conduit bends, conduit fittings, outlet boxes, pullboxes, junction boxes, conduit anchors/supports, grounding/bonding for a complete and operating conductor/wire raceway system.
 5. Metal and nonmetal conduits shall be provided mechanically continuous between termination connection points. Metal conduit shall be provided electrically continuous between termination connection points.
 6. Individual conduit paths and home runs shown on the Drawings shall be maintained as separate individual conduits for each homerun and path.
 7. Conduits, conduit fittings and installation work occurring in classified hazardous materials locations shall comply with applicable Code Class 1 Division 1 Requirements, unless specifically noted otherwise.
 8. Transitions between conduits constructed of different materials and occurring in above grade locations shall be allowed only at outlet boxes, junction boxes, pull boxes and equipment enclosures unless specifically indicated otherwise. Provide outlet boxes and junction boxes.
 9. Metal conduit terminating to nonmetal enclosures; terminating into metal enclosures with "concentric ring" knockouts; terminating into metal enclosures with knockout reducing washers, including but not limited to equipment housings, outlet boxes, junction boxes, pull boxes, cable trenches, manholes, shall be provided with a ground/bonding lug integrated with the conduit termination conductor fitting construction, by the Fitting Manufacturer. The lug shall provide for connection of a grounding/bonding conductor (insulated or uninsulated). The grounding lug shall be located on the fitting, inside the termination enclosure.
 10. The type of conduit, type of conduit fittings, and type of conduit supports and method of conduit installation shall be suitable for the conditions of use and conditions of location of installation based on the Manufacturer's recommendations; based on the applicable Codes and based on the Requirements of the Contract Documents.

B. RMC Installation Locations

RGS, IMC conduits and RGS, IMC fittings shall be installed in the following locations:

1. Embedded in floors, walls, ceilings, roofs, foundations, and footings constructed with concrete.
2. Embedded in walls and foundations constructed with brick and masonry.
3. Interior of buildings, within 9-feet of finish floor lines for exposed conduit locations.
4. Exterior of building for exposed conduit locations.
5. Damp or wet locations, exposed or concealed locations.
6. Exposed on roofs.
7. In hazardous materials areas and locations; below hazardous materials areas and locations; above hazardous materials areas and locations.
8. Exposed on utility service poles, for pole risers less than 9-feet above finish grade.
9. RMC conduit and RMC fittings may be installed in any location where EMT and FMC conduit is permitted to be installed.

C. PVC Coated RMC Installation Locations

PVC coated RMC conduit and PVC coated RMC fittings shall be installed in the following locations:

1. Underground conduit locations for elbows and bends with a radius of less than 36-times the conduit diameter.
2. Underground vertical risers extending above grade.
3. Entire length of underground conduits for the following circuits:
 - a. Audio microphones
 - b. Lighting dimming controls
4. Installed in contact with earth or corrosive materials.
5. Exposed in "cold" rooms and "refrigerated" rooms, rooms with a maintained temperature below 65 degrees Fahrenheit.

D. EMT Installation Locations

EMT conduit and EMT fittings may be installed in the following locations, for circuit conductors operating below 600 volts to ground; locations containing only "non-hazardous materials"; only dry locations:

1. Concealed in hollow non masonry/non-concrete, metal stud frame and wood stud frame walls and floors.
2. Concealed above ceilings.
3. Exposed inside interior enclosed crawl spaces.
4. Exposed interior locations placed 9-feet or higher above finished floors (except as described in paragraph below at lower heights).
5. Exposed on walls and ceilings (any height) in the following dedicated function areas, interior enclosed room locations:
 - a. Indoor enclosed electrical equipment rooms and closets.
 - b. Indoor enclosed data and telecommunication terminal rooms and closets.
 - c. Indoor enclosed HVAC equipment rooms and closets.
6. Any location where FMC is described to be installed, except as the final connection to rotating or vibrating equipment.

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E. FMC Installation Locations

FMC conduit and FMC fittings may be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only "non-hazardous materials"; only dry, interior locations:

1. Concealed in hollow non-masonry metal stud frame and wood stud frame fully enclosed walls.
2. Concealed above fully enclosed ceiling spaces.
3. FMC conduit shall be installed in continuous lengths between termination points. FMC shall not be "spliced" or coupled directly to FMC or any other conduit type under any circumstance.
4. The maximum continuous length of FMC that shall be installed between termination end points is 15-feet. Circuits requiring continuous conduit lengths exceeding 15 feet between termination end points shall be installed using either RMC or EMT conduits. FMC lengths shorter than 16-inches are prohibited.
5. The minimum size FMC conduit shall be as shown on the Drawings but not be less than the following:
 - a. FMC lengths of 6-feet or less, minimum FMC conduit size shall be 0.50-inch.
 - b. FMC lengths exceeding 6-feet, minimum FMC conduit size shall be 1.0-inch.

F. LTFMC Installation Locations

LTFMC conduit and LTFMC fittings shall be installed in the following locations for circuit conductors operating below 600 volts to ground; locations containing only "non-hazardous materials":

1. Final electrical connection to vibrating or rotating equipment; control and monitoring devices mounted on vibrating and rotating equipment including the following. Minimum conduit length shall not be less than 24-inches:
 - a. Motor, engines, boilers, solenoids, and valves.
 - b. Fixed mounted "shop" (manufacturing) production equipment.
 - c. Fixed mounted food preparation equipment and "kitchen" equipment.
2. All locations where exposed flexible conduit connections are required, both indoor and outdoor.
3. Final connection to indoors electrical transformers. Minimum conduit length shall not be less than 24-inches; maximum conduit length shall not exceed 72-inches.
4. Do not install LTFMC located in environmental air plenums.

G. RNMC Installation Locations

RNMC conduit and RNMC fittings shall be installed in the following locations containing only "non-hazardous material":

1. Underground, concealed below earth grade, unless specifically noted or specified otherwise.
2. Exposed on utility service poles, for pole risers at 9-feet or higher above finish grade, Schedule 80 PVC only.
3. RNMC type "EB" conduit(s) shall be concrete encased along the entire length of the conduits for all installation locations.
4. Non-metal type raceways and RNMC type conduit shall not be installed inside buildings.

H. Combi-Duct Installation Locations

Combi-duct conduits shall be installed where shown on the Drawings. Combi-duct shall be installed underground (below grade) as follows:

1. Do not install exposed or inside buildings above grade.
2. Provide a 0.25-inch pull rope in each inner duct.
3. Radius and elbows shall be rigid non-metallic, PVC, Manufacturer factory fabricated, in lieu of PVC coated RMC conduit.
4. Inner ducts shall be supported by internal spacers inside the enclosing outer duct.
5. Provide end bell and three-hole "snug-plugs" at each entrance end of Combi-duct into pullboxes, manholes, equipment cabinets stubups and Combi-duct terminations. Compression type "snug-plugs" shall provide watertight and airtight seal between inner and outer ducts and around future cables installed in inner duct.

I. Conduit Installation

1. Conduit Supports

- a. Securely and rigidly support all raceways/conduits from the building structure. Raceways/Conduits shall be supported independent of all piping, air ducts, equipment ceiling hanger wires, and suspended ceiling grid systems. Secure conduit to structural element by means of UL listed and approved hangers, fasteners, "C" channels and pipe clamps.
- b. Provide conduit supports spaced along the length of the conduit as follows:
 - 1) RMC and EMT conduit, maximum not to exceed 96-inches on center; within 24-inches of each conduit bend and conduit termination location.
 - 2) FMC and LTFMC conduit, maximum not to exceed 24-inches on center; within 6-inches of each conduit bend and conduit termination location.
- c. Suspended conduit methods:
 - 1) Individual, suspended raceways/conduits separated by more than 12-inches from any other conduit and suspended from ceilings and roofs shall be supported as follows:
 - a) Conduits smaller than 1.5-inches by means of hanger rods or hanger wires.
 - b) Conduits 1.5-inches and larger by means of hanger rods.
 - c) The conduit shall attach to the hangers with pipe clamps.
 - 2) Suspended raceways/conduits positioned within 24 inches of any other conduit shall be grouped and supported by hanger rods using trapeze type conduit support channels ("C" channels). Conduits shall individually attach to common channels side-by-side, with pipe clamps.
- d. Non-suspended conduit methods:
 - 1) Individual raceway/conduits placed against wall/ceiling/floors, placed inside hollow wall/ceiling construction or structure framing (i.e., "dry- wall" or plaster hollow wall construction), shall be secured by means of individual pipe clamps and fasteners attached to the framing studs or other structural members and the conduit/raceway.
 - 2) Provide common "C" channel supports for all multiple raceway/conduits placed against vertical or horizontal surfaces and positioned within 24-inches of other raceways/conduits. Attach

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- channels to the framing studs or other structural members. Attach the conduits/raceway individually to common channels, side-by-side, with pipe clamps.
- 3) The use of toggle bolts is prohibited.
- e. Conduit rising from floor for motor connection shall be independently supported if extending over 18-inches above floor. Support shall not be to a motor or ductwork, which may transmit vibrations.
- f. Provide conduit anchoring, conduit support and conduit bracing systems conforming to Earthquake Seismic Requirements. The conduit support / anchoring system capacity shall include the weight of the conduits, conduit fittings, conduit supports and conductors/wires/cables installed in the conduits plus a 300% safety factor. Submit Shop Drawing details showing each typical conduit anchor, conduit support and conduit brace location. Submit Structural Calculations performed by and signed by a Professional Structural Engineer (P.E.) with a P.E. License, Registered in the State of California, U.S.A.
2. Conduit separation:
- a. Conduit installed underground or below building slab without full concrete encasement: Shall be separated from adjacent conduits of identical systems (i.e. signal to signal, data to data, power to power, control to control etc.) by a minimum of 3-inches. Conduits of non-identical systems (i.e. signal to power; data to power; power to control; signal to control, etc.) shall be separated by a minimum of 12-inches.
- b. Conduit installed underground with full concrete encasement; shall be separated from adjacent conduits of similar systems (100 volt and less) by a minimum of 2-inches; conduits for non-power systems (100 volts and less to ground) shall be separated by a minimum of 6-inches from power circuits (over 100 volts to ground); conduits for power circuits shall be separated from adjacent conduits of similar power systems (over 100 volts to ground) by a minimum of 3-inches.
- c. Separation of conduits entering termination points or crossing other conduits may be reduced as required within 60-inches of the termination or crossing points.
- d. Conduits containing Utility Company service circuits (i.e. electrical power, telephone, or cable television) shall be separated a minimum of 12-inches from all other utilities and conduits, with or without concrete encasement; metallic or non-metallic conduit, above grade or underground conduit locations.
- e. Conduits shall be separated from hot water piping, exhaust flues/ chimneys, steam piping, boilers, furnaces, ovens by a minimum of 12-inches.
3. Conduit stubs:
- a. Branch circuit and telephone conduits turned up from floor at the following locations shall terminate each conduit in a flush conduit coupling at the floor and then extend into partition or to equipment. Refer to District's Representative's Drawings for location of walls and partitions.
- 1) Interior demountable partitions.
 - 2) Below, into or adjacent to equipment not installed directly adjoining to a wall.
 - 3) Up from below the floor into hollow stud frame walls.
- b. From each panel, and signal cabinet which is wall mounted, stub up from top of the panel/cabinet a minimum of three 1-inch conduits to the nearest accessible ceiling spaces or other accessible location. Where the floor

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- below the panel is accessible or is a ceiling space, stub an additional three 1-inch conduits from the bottom of the panel into the accessible space below the panel. Cap conduits for future use.
- c. Conduits stubbed underground outside of building line for future use shall be terminated a minimum of 5-feet clear (whichever distance is greater) of building or adjacent concrete walks and AC paving. The stubout conduit shall be capped. Provide concrete monuments, 6-inches by 6-inches by 15-inches deep, buried flush with grade over the capped ends. The face of monument shall be furnished with 3-inch square brass plates securely mounted and engraved with the number and size of conduits and type of service (i.e., "POWER", "TEL.", etc.).
 - d. Conduits stubbed into ceiling or floor spaces from outlets for telephone, video, computer/data or television shall be provided with an insulated throat bushing, on the end of each conduit stubout.
 - e. Conduit stubouts from outlet boxes and equipment located in hollow stud walls, into ceiling and floor spaces, shall be EMT or RMC conduit. The stubouts shall terminate into the ceiling and floor spaces with a conduit termination connector fitting.
 - f. Empty conduit stubs into building spaces and equipment shall be individually identified with an "ID-tag" located at each end of the conduit. The ID-tag shall state the origination point and termination point of the respective conduit (i.e., "from PNL-A/to Room #121"; "from outlet #24/to outlet #17 in Room #120"; etc.).
 - g. Provide a conduit termination fitting with insulated throat bushing and mechanical ground lugs at each conduit "stub-up" location.
4. Conduit concrete encasement:
- a. Conduits which are run underground exterior to building slab shall be continuously concrete encased except, 15-amp and 20-amp power branch circuit conduits underground do not require concrete encasement.
 - b. PVC rigid-non-metallic-type EB conduit, of any size and any location shall be continuously concrete encased the full length of the conduit installation, including under building slab.
 - c. Concrete for encasement of underground conduits shall be 2000-PSI 28-days cure strength with a mix of cement, sand, water and maximum of $\frac{3}{4}$ -inch gravel. Concrete encasement of conduits shall be continuous without voids. The encasement shall extend 3-inches past the edges of all conduits on all sides of the circuit. Provide ten pounds of red oxide cement coloring uniformly mixed with each cubic yard of concrete for conduit encasement.
 - d. Conduits located below or adjacent to structural foundations shall be separated from the foundation by a minimum of 12-inches. Conduits located below structural foundations shall be fully and continuously concrete backfilled and encased between the bottom of the foundation to the bottom of the conduits. The concrete shall be 4000 PSI 28-day cure strength instead of 2000-PSI concrete.
 - e. Conduits of any size and type (including 15-amp and 20-amp power branch circuits) located under roads, paved areas and "transit-system" right of way shall be concrete encased.
5. Underground conduits:
- a. Three or more underground conduits larger than 1-inch in size and occupying the same trench shall be separated and supported on factory fabricated, non-metallic, duct/conduit support spacers. The spacers shall be modular, keyed interlocking type, "built-up" to accommodate quantity,

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size orientation and spacing of installed conduits. The spacers shall maintain a constant distance between adjacent conduit supports and hold conduits in place during trench backfill operations. Minimum support spacer installation interval along with length of the conduits shall be as follows:

- 1) Concrete encased conduits, not less than 8-feet on center.
- 2) Non-concrete encased conduits, not less than 5-feet on center.
- b. Provide trenching, excavation, shoring and Backfilling required for the proper installation of underground conduits. Tops of backfill shall match finish grade.
- c. Bottoms of trenches shall be cut parallel to "finish grade" elevation. Make trenches 12-inches wider than the greatest diameter of the conduit.
- d. Back-filling Trenches for Conduits without Concrete Encasement Requirements
 - 1) Conduits which are not required by the Contract Documents to be concrete encased and are located exterior to building slab, shall be set on a 3-inch bed of damp clean sand. Conduit trenches shall be backfilled to within 12-inches of finished grade with damp sand after installation of conduit is completed. Remainder of backfill shall be native soil.
 - 2) Conduits located under a building which are not required by the Contract Documents to be concrete encased, shall be completely backfilled and compacted with clean damp sand to the same level as the building foundation pad.
 - 3) Provide a continuous yellow 12-inches wide flat plastic tracer tape, located 12-inches above the conduits in the trench. The tracer tape shall be imprinted with "Warning-Electric Circuits" a minimum of 24-inches on center.
- e. Backfilling trenches for conduits under paved areas:
 - 1) In addition to the Requirements of conduit concrete encasement, conduits under walkways, roads, parking lots, driveways, and buildings shall be cast in place concrete "slurry mix" backfill. The slurry mix shall cover each side and top of conduits and conduit concrete encasement. The slurry mix shall be continuous to the underside of the finish subgrade surface.
- f. Backfilling trenches for conduits with Concrete Encasement Requirements by the Contract Documents:
 - 1) Trenches with all conduits concrete encased shall be backfilled with clean damp sand when located under building pads.
 - 2) Trenches with all conduits concrete encased and not located under a building pad and not located under paved areas shall be backfilled with clean damp sand or native soil.
- g. Backfill material:
 - 1) Sand and native soil backfill of trenches shall be machine vibrated in 6-inch lifts to provide not less than 90% compaction of backfill.
 - 2) Soil backfill shall have no stones, organic matter or aggregate greater than 3-inches.
 - 3) Concrete and slurry mix (2000-PSI) shall be machine vibrated during installation to remove "air-voids".
 - 4) The slurry mix shall consist of concrete, clean rock, clean sand and clean water mixture. Maximum shrinking of slurry mix shall not exceed 5% wet to dry.

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- h. Do not backfill until District's Representative has approved installation and As-Built Drawings are up to date. Promptly install conduits after excavation has been done, so as to keep the excavations open as short a time as possible. Excess soil from trenching shall be removed from the site.
 - i. Install underground conduit, except under buildings, not less than 24-inches below finished grade in non-traffic areas and 30-inches below finished grade in traffic areas, including roads and parking areas. Not less than 48-inches below finished grade under public/private transit system right of way and railroad right of way. Dimensions shall be measured to the top of the conduit.
 - j. Conduit crossing existing underground utilities shall cross below the bottom depth of the existing utilities. If the top portion of the existing utility depth below finish grade exceeds 72-inches and the specified separation and depths are maintained when crossing over the top of the existing under-ground utility, the conduit may cross above the existing underground utility.
 - k. Provide long radius horizontal bends (minimum radius of 36-times the conduit diameter) in underground conduits where the conduit is in excess of 100-feet long.
 - l. Conduits installed below grade and on grade below buildings, shall not be smaller than 0.75-inches. Conduits for circuits exceeding 600-volts shall not be smaller than 5.0-inches.
 - m. Underground conduits entering a building shall be sloped. The conduit direction of slope shall be away from the building, and shall prevent water in the conduit from "gravity draining" towards the building. The conduit slope "high point" shall originate from the building, out to the first exterior pullbox, manhole etc. exterior conduit termination "low point". The minimum slope angle shall be a constant 8-inches (or greater) of fall for each 100-feet of conduit length.
 - n. Dewatering:
 - 1) Provide pumping to remove, maintain and dispose of all water entering the excavation during the time the excavation is being prepared, for the conduit laying, during the laying of the conduit, and until the backfill at the conduit zone has been completed. These provisions shall apply on a continuous basis. Water shall be disposed of in a manner to prevent damage to adjacent property. Trench water shall not be drained through the construction. Groundwater shall not be allowed to rise around the pipe until joining compound has firmly set.
 - 2) The District's Representative shall be notified 48 hours prior to commencement of dewatering.
6. Raceway/Conduits, which are installed at this time and left empty for future use, shall have 0.25-inch diameter polyvinyl rope left in place for future use. The pull rope shall be 500-pound minimum tensile strength. Provide a minimum of 5-feet of slack at each end of pull ropes.
 7. Unless otherwise restricted by Structural Drawings and Specifications, the maximum size conduit permitted in concrete slab on-grade, walls, ceilings and roofs constructed of masonry or concrete shall not be greater than 20% of the concrete/masonry thickness. Conduits installed in these locations shall not cross.
 - a. Conduits shall not be installed in cast-in-place concrete floors.

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8. Provide openings in building structures for conduit penetrations:
 - a. New construction shall be provided with conduit sleeves, to provide conduit penetrations.
 - b. Existing construction shall be drilled (core drill masonry and concrete) and provide conduit sleeves installed after drilling, to provide conduit penetrations.
 - c. Where the structure penetrations for underground conduits penetrating through foundations will not comply with the (restriction/penetration) shown in the Contract Documents, install the conduits below and clear of the foundation lowest point.
9. Conduit bends risers and offsets:
 - a. The minimum bend radius of "factory or field" fabricated conduit bends shall not be less than the following. The bend radius shall be measured at the surface, inside radius of the conduit wall:
 - 1) FMC and LTFMC conduit - conduit minimum bend radius 12-times the conduit diameter.
 - 2) RMC and EMT conduit minimum bend radius - conduit for power circuits over 100 volts and less than 600 volts, 8-times conduit diameter. Conduit for power circuits over 600 volt, 12-times conduit diameter. Conduit for low voltage, signal and fiber optic circuits, 10-times conduit diameter.
 - 3) RNMC conduit - conduit minimum bend radius 36-times the conduit diameter. Under building reduce minimum bend radius to 10-times the conduit diameter. Conduit bends and offsets in RNMC with less than 36-times conduit diameter bend/offset radius shall be RNMC PVC Schedule 80 or PVC coated RGS.
 - 4) Conduits for Utility Company conductors. Conduit minimum bend radius shall comply with the respective Utility Company Requirements.
 - b. Bends and offsets in conduits shall be kept to an absolute minimum. The total summation of all bends and offsets permitted in a conduit segment, occurring between two conduit termination/connection end points, shall not exceed the following, including conduit fittings:
 - 1) RMC and EMT conduit - 360 angular degrees
 - 2) FMC and LTFMC conduit - 180 angular degrees
 - 3) RNMC conduit - 270 angular degrees
 - c. Each field fabricated conduit offset, bend and elbow which are not the standard product of the Raceway/Conduit Manufacturer shall be mandrel tested. The test shall be conducted after the conduit installation is complete and prior to pulling-in any wire, in the same manner as for underground conduits.
 - d. Factory manufactured angle connector conduit fittings shall be installed in exposed conduit locations only. Installation in locations normally concealed from view shall not be permitted. Not more than one factory manufactured angle connector shall be permitted in any length of conduit between conduit termination end points.
 - e. RNMC conduit risers from below grade shall be PVC coated RGS. Conduit risers, bends or offsets entering into a building shall be PVC coated RGS.

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- f. If three or more conduit-bends of the same conduit size and same conduit material type, installed, as part of the Contract Work, fail to comply with the required minimum conduit bend radius or conduit angular degree limits. The following corrective actions shall occur:
 - 1) The Contractor shall remove all the non-complying conduit bends and the respective wire in the conduit from the Project Site. Provide new conduit and wire, complying with the Contract Documents.
 - 2) Where the conduit bends similar to the non-complying conduit bends are installed concealed in walls, floors, above ceilings or below grade, the Contractor shall expose the conduit bends to allow visual observation.
 - 3) The Contractor shall remove the non-complying conduit bends and dispose of the Project Site. The Contractor shall provide new conduit bends and conductors complying with the Contract Documents.
 - 4) All the costs to correct the deficient material and work along with costs to repair the direct, indirect, incidental damages and Contract delays shall be the sole responsibility of the Contractor and shall be included in the bid price.
10. Expansion joint, deflection joint and seismic joint fittings.
 - a. Provide a conduit expansion fitting for each conduit length and conduit type as follows (Note - The installation of specified combination expansion/deflection fittings at seismic joints shall satisfy this Spacing Requirement also):

Conduit Type	Conduit	Fitting Length Spacing
1) RMC and EMT	Exposed exterior locations	200-feet
2) RMC and EMT	Interior weather protected locations	400 feet
 - b. Provide a conduit combination expansion/deflection fitting for each conduit, crossing the following elements:
 - 1) At each building or non-building structure seismic joint.
 - 2) At each building or non-building structure expansion joint.
 - 3) At each conduit penetration of a "sound-rated" wall, floor or ceiling.
11. Provide two locknuts and an insulated throat bushing at each metal conduit terminating at enclosures, including but not limited to outlet boxes, junction boxes, terminal cabinets, switchgear, transformers, switchboards, distribution panels and panelboards.
12. Provide metallic or plastic closure caps on all conduit ends during construction, until installation of conductors in the respective conduit.
13. Conduit run exposed, shall be run at right angles or parallel to the walls or structures. All changes in directions, either horizontally or vertically, shall be made with conduit outlet bodies as manufactured by Crouse Hinds, OZ or equal. Conduits run on exposed beams or trelliswork shall be painted to match surrounding surfaces.
14. Conduit exposed on roof:
 - a. Conduits installed exposed on roofs shall be installed on conduit sleepers. Place the conduit sleepers a maximum 5-foot on center along the entire length of the conduit; under conduit expansion/deflection fittings; under each junction box and within 24-inches of each conduit bend.
 - b. Provide a conduit support "C" channel continuous along the top length of the sleeper and rigidly bolted to the sleeper. Conduits shall be loosely fastened to each sleeper "C" channel with pipe clamps to allow for relative movement between the sleeper and conduit.

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- c. Conduits shall not block or interfere with roof hatches, doors, ventilation openings, dampers, equipment access panels/doors, roof water drainage.
 - e. Conduit sleepers shall be fabricated from "clear" solid redwood 4-inches by 4-inches (nominal) size. Sleeper length shall extend a minimum of 9-inches past the conduits attached to the sleeper, but in no case shall the length of the sleeper be less than 24-inches.
 - f. Provide a pad under each sleeper; sleepers shall not be installed in direct contact with the roofing. Sleeper pads shall extend a minimum of 6 inches past each side of the sleeper. The sleeper pad shall be semi-rigid mineral surfaced composition board, not less than 0.375-inch thickness, bituminous impregnated, manufactured for application on the specific roofing material. Remove roofing "ballast" (gravel) under pad, prior to installation of sleeper pad. Do not puncture roof membrane.
 - g. Position the "length" of the conduit sleepers' perpendicular to the roof slope, to prevent obstruction of roof drainage water flow. Where the conduit routing prevents placing the conduit sleeper parallel to the roof slope, provide two separate sleeper pads for the conduit sleeper, with a continuous 3-inches wide water drainage gap between the sleepers. Align the water drainage gap to allow unimpeded water travel along the roof slope drainage flow line between the pads.
 - h. Sleepers and sleeper pads shall be set in nonhardening mastic, a minimum of 0.25-inch thickness. Mastic shall be inorganic, nonhardening, and complying with ASTM-D1227. Mastic shall be applied with continuous uniform coverage, minimum 0.25-inch thickness, on all the surfaces of each conduit sleeper and on the sleeper pad contact surface with the roof.
15. Rigid steel conduit or electrical metallic tubing shall not be strapped or fastened to equipment subject to vibration or mounted on shock absorbing bases.
16. RMC conduit threads:
- a. Machine cut threads on RMC conduit required for field fabrication shall comply with NPS and ANSI-B1.20.1.
 - b. The length of bare metal exposed during thread fabrication shall be completely covered by conduit couplings and fittings. Additionally, the thread length shall insure that conduit joints will reach "torque" tightness and become secure before conduit ends "butt" together and before conduit ends "butt" into the "shoulders" of other conduit fittings.
 - c. Running threads or right/left handed threads shall not be used to connect RMC.
17. RNMC conduit:
- a. Joints and fittings shall be solvent welded to RNMC conduit. Joints and fittings shall be watertight and airtight after fabrication.
18. Tighten each conduit fittings and fitting appurtenance, to the "torque" (allowable tolerance $\pm 5\%$) value recommended by the Fitting Manufacturer and applicable Code. If three or more conduit fittings are found to not be in compliance with the Manufacturer's "torque" (tightness) recommendations, the following corrective actions shall occur:
- a. The Contractor shall tighten "re-torque" the defective fittings and all similar conduit fittings installed as part of the Contract Documents in the presence of the District's Representative.
 - b. If the respective conduit fittings similar to the deficient "torque tightness" fittings are installed concealed in walls, floors, above ceilings or below grade, the Contractor shall expose the fitting, to allow retightening each similar conduit fitting to the Manufacturers recommended "torque" values.

- c. All the cost to repair the direct, indirect, incidental damages and Contract delays resulting from complying with these Requirements shall be the sole responsibility of the Contractor and shall be included in the bid price.
- 19. Horizontal directional boring for underground conduit:
 - a. Provide a directional guided horizontal “bore-hole” underground conduit installation where one or more of the following conduits occur:
 - 1) Continuous trenching excavation and backfill for conduit installation is not permitted by the Contract.
 - 2) Where continuous trenching excavation due to the existing surface and below grade conditions and restrictions, is not possible or practical to excavate a trench.
 - b. Provide “path-tracing” of the underground bore head, from the surface, along the entire horizontal bore length. Path tracing shall use electronic transmitters and receivers, continuously communicating the underground bore head locations and depth to the bore equipment operator. The directional boring system shall employ active tracking and directional position/steering control of the bore equipment drill head location. The active tracking system shall provide a portable receiver/transmitter unit for tracking the position of the moving drill head; a sensor “Sonde” unit on the drill head for tracking signals to the receiver/transmitter; and a drill head tracking data view display located at the boring equipment operator position to view the drill head position information sent from the portable receiver/transmitter. As manufactured by SPX-Radiodetection Company or similar products.
 - c. Provide vertical pilot excavations not more than 50-feet on center along the path of the bore-hole to intercept the horizontal bore-hole routing, provide excavations at the beginning and end terminals staging points of the horizontal bore-hole.
 - d. Provide full-depth “shoring” of the vertical pilot excavations. Remove the shoring, backfill, compact and repair the excavations when conduit installation is complete.
 - e. “Drilling-fluid” shall be used during “back-reaming” and “pullback”, pumped through the drill pipe to the bore drill head.
 - f. Directional guided horizontal drilling shall employ equipment specifically designed and manufactured for the process. The Equipment Manufacturer shall train Bore Equipment Operating Personnel in the proper operation of said equipment.
 - g. Locate the position, size, depth and identify all underground “cross-bore” existing underground utilities, pipes, structures and conflicts along the entire bore path of each underground bore, prior to initiating directional boring work. Notify respective Agency for each “cross bore” potential crossing. Comply with the recommendations of the Cross Bore Safety Association (CBSA).
 - h. Horizontal, directionally guided boring equipment, as manufactured by Ditch Witch; Vermeer Manufacturing; or Case Corporation.

J. Conduit Seals

- 1. Provide conduit seal fittings at each location where a conduit transitions or passes through the following areas and where indicated on the Drawings:
 - a. Refrigerated areas.
 - b. Temperature control rooms including warming rooms, steam rooms, saunas etc.
 - c. Classified hazardous material areas.

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- d. Water intrusion areas.
2. Provide conduit seals on each conduit entering a building from a below grade area located outside the building (i.e., basement, vault etc.) and connecting to the following types of equipment
 - a. Transformers
 - b. Panelboards
 - c. Motor control centers
 - d. Switchboards
 - e. Switchgear
 - f. Motors
 - g. Terminal cabinets
 - h. Terminal backboards
 - i. Cable trenches
3. Conduit seals shall be installed in locations where the fitting is visible and accessible.

K. Nailing Shields

1. Provide "nail" shields where FMC conduit and conductors not installed in a conduit are installed through wood stud and wood frame construction. The nail shield shall provide a barrier resistant to "nailing" fasteners through the stud, and penetrating into the FMC and conductors.
2. The nail shields shall be flat nominal 1.5-inch by 3-inches, 14-gauge steel, and hot dip zinc galvanized with "nailing spurs".
3. Provide nailing shields on the front face and rear face of each FMC penetration. The shield shall be centered on each penetration through the respective framing, stud framing blocking, and stud framing plates.

L. Conduit Bodies

1. Conduit bodies shall be installed in exposed conduit locations only or above accessible ceilings.
2. Conduit bodies shall be accessible for removing body cover and pulling wire through the conduit body.
3. Conduit bodies shall not be installed inside enclosed walls.

M. Preparation of Reuse of Existing Conduits

1. Prepare existing conduits shown to be reused as part of Contract Work as follows: Complete the required work prior to installing any conductors or cables in respective existing conduits.
 - a. "Rod" out existing raceways to be used under this contact, with approved test and flexible mandrels to remove all obstructions to clear debris from inside conduits.
 - b. Use test mandrels at least 12-inches long, 0.25-inch less than diameter of duct at center, tapering to 0.5-inch less than duct size at ends.
2. If test mandrels cannot be pulled through raceways, Contractor shall perform the following to clear the existing raceways:
 - a. Force rigid or semi-rigid rods through the raceways to clear the obstructions from one to both ends of the raceway.
 - b. Force a power driven rotating router device through the conduit from one or both ends of raceways. Device shall incorporate small diameter cutting blades. Repeat the "router" process in incremental stages to a cutting blade diameter approximately $\frac{1}{8}$ -inch smaller than the raceway inside diameter.

3. After clearing the raceway of obstructions, pull a test mandrel or brush through the raceway to clear the remaining debris from the raceway.

3.04 WIRE AND CABLE

- A. Branch circuit and fixture joints for #10AWG and smaller wire shall be made with UL-approved connectors listed for 600 volts, approved for use with copper and/or aluminum wire. Connector to consist of a cone-shaped, expandable coil spring insert, insulated with a nylon shell and two wings placed opposite each other to serve as a built-in wrench or shall be molded one-piece as manufactured by 3M- "Scotchlok".
- B. Branch circuit joints of #8AWG and larger shall be made with screw pressure connectors made of high strength structural aluminum alloy and UL-approved for use with both copper and/or aluminum wire as manufactured by Thomas & Betts. Joints shall be insulated with plastic splicing tape, tapered half-lapped and at least the thickness equivalent to 1.5-times the conductor insulation. Tapes shall be fresh and of quality equal to Scotch.
- C. Use UL listed pulling compound for installation of conductors in conduits.
- D. Correspond each circuit to the branch number indicated on the panel schedule shown on the Drawings except where departures are approved by the District's Representative or the District's Representative.
- E. All wiring, including low voltage, shall be installed in conduit.
- F. Control wiring to conform to the wiring diagrams shown on the Mechanical Drawings and the Manufacturer's wiring diagrams.
- G. All splices in exterior pull boxes and light poles shall be cast resins encapsulated.
 1. Power conductor splices - 3M Scotchcast Series 82/85/90; Plymouth or equal.
 2. Control and signal circuits 3M Scotchcast Series 8981 through 8986, Plymouth or equal.
- H. Neatly group and lace all wiring in panelboards, motor control centers and terminal cabinets with plastic ties at 3-inch on centers. Tag all spare conductors.

3.05 CHEMICAL GROUND ROD

- A. General
 1. Install ground rod system in compliance with Manufacturer's instructions.
 2. Install rods vertically. Where subterranean hard rock conditions prevent vertical installation horizontal "L" shape ground rod shall be installed.
 3. Where ground rod is installed in an indoors dry location set ground box flush with finish floor. Where ground rod is installed outdoors set the top of the ground box four inches above finish grade.
 4. Do not remove sealing tape from ground rod holes until time of installation in ground.
 5. Separate ground rods from all other grounding electrodes and from each other by not less than 12-feet horizontal distance.

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- B. Excavation
 - 1. Vertical installation bore a 12-inches diameter vertical hole in the ground 6-inches deeper than ground rod length.
 - 2. Horizontal installations excavate a 12-inches wide trench, slope rod and trench to insure end cap of rod is 2-inches lower than the elbow.
- C. Backfill
 - 1. Surround the entire rod with a minimum of 10 inches of bentonite clay mixed with water at six times volume to form a paste. Approximately 14-gallons for each 50-pounds of clay. Remove any excavation liners from the rod excavation area.
 - 2. Install ground box and complete backfill.
- D. Connect grounding electrode conductor(s) to ground rod.

3.06 CABLE RACKS

- A. General
 - 1. Provide cable racks in precast and cast-in place concrete pullboxes, manholes and cable trenches.

3.07 TESTING

A. Testing Conduit and Conduit Bends

The Contractor shall demonstrate the usability of all underground raceways, and field fabricated conduit bends installed as part of this Contract.

- 1. A round tapered segmented semi-rigid mandrel with a diameter approximately $\frac{1}{4}$ -inch smaller than the diameter of the raceway shall be pulled through each new raceway.
- 2. The mandrel shall be pulled through after the raceway installation is completed. Conduits which stubout only, may have the mandrel pulled after the concrete encasement is completed, but prior to completing the backfill.
- 3. District's Representative shall witness the raceway testing for usability. A Representative of the respective Utility Company shall witness the raceway testing where applicable.
- 4. Contractor shall repair/replace any conduit and conduit bend provided under this Contract which will not readily pass the mandrel during this test.

END OF SECTION 26 0533
121619/223077

SECTION 26 2416

BRANCH CIRCUIT PANELBOARDS AND TERMINAL CABINETS

PART 1 GENERAL

1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete, as shown on the Drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
 - 1. Examine all other Specification Sections and Drawings for related work required to be included as work under Division 26.
 - 2. General Provisions and Requirements for electrical work.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. Provide Manufacturers Catalog Data for panels, cabinets, and circuit breakers.
- B. Provide Shop Drawing showing panel circuit arrangements, size, voltage, ampacity, overcurrent protective devices, etc.
- C. Provide Nameplate Engraving Schedule.
- D. Short Circuit, Coordination and Arc-Flash
 - 1. Perform and submit engineered settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and settings to provide the selective Coordination within the limits of the specified equipment, per the latest applicable Standards of IEEE and ANSI. Provide electrical system short circuit fault analysis, both 3-phase line-to-line and 1-phase line-to-ground calculations as part of the Coordination Analysis recommendations. Provide Electric Arc-Flash calculations as part of the Coordination Analysis recommendations.
 - 2. The information shall be submitted in both tabular form and on time current log-log graph paper, with an engineering narrative. Written narrative describing data, assumptions, analysis of results and prioritized recommendations, six copies.
 - 3. The goal is to minimize an unexpected but necessary electrical system outage and Personnel exposure to the smallest extent possible within the fault occurrence location, using the specified Contract Equipment; shall comply with, but not limited to:
 - a. IEEE-242, Recommended Practices for Protection and Coordination of Industrial and Commercial Distribution.
 - b. IEEE-399, Recommended Practice for Industrial and Commercial Power System Analysis.
 - c. IEEE-1584, Guide to Performing Arc-Flash Hazard Study.
 - d. CEC/NEC
 - 4. Electrical equipment including switchgear, switchboards, electrical panels, and control panels, transformers, disconnects, etc., shall each be labeled by the Manufacturer with "Electrical-Arc-Flash" warning signs. The signs shall explain a hazard to Personnel may exist if the equipment is worked on while energized

- or operated by Personnel, to wear the correct Protective Equipment/clothing (PPE) when working "Live", or operating "Live" equipment and circuits.
5. The Contractor shall independently contact the serving Utility Company to obtain the current system short circuit amps or available fault current.
 6. The Contractor shall independently obtain As-Built Drawings for the existing infrastructure to establish lengths. If As-Built Drawings are no available, the Contractor shall research existing conditions and make reasonable but conservative estimates of conductor length. Where existing conductors have been re-used, the Contractor shall confirm conductor quantity, size, and conduit type.
- E. Provide submittal for Test Plan sequence, procedures, tester qualifications and blank test forms. Provide submittal report of test results for review and approval.

1.03 SEISMIC EARTHQUAKE AND WIND LOADING WITHSTAND, TESTING AND CERTIFICATION (ADDITIONAL REQUIREMENTS)

- A. General
1. The complete panels and terminal cabinet assemblies; including circuit protection devices, meter, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
 - a. Wind loading all outdoor equipment locations.
 - b. Earthquake Seismic and CBC/IBC Seismic withstand all indoor and all outdoor equipment locations.
 2. Shall withstand, survive and maintain continuous non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
 3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance test seismic qualification shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
 4. Provide three dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
 - a. 110MPH – West Coast States USA and Hawaii, per ASCE/SEI 7-10.
 5. Seismic test shall be performed by a third party independent Test Laboratory. Wind Analysis and Seismic Testing and Reports shall be certified, signed and "Stamped" by PE Professional Engineer Licensed and in good standing in the State, Civil Engineer or Structural Engineer.

PART 2 PRODUCTS

2.01 PANELBOARDS AND DISTRIBUTION PANELS

- A. Shall be flush or surface mounting as indicated with group-mount circuit protection devices as shown on panel schedule, hinged lockable doors, index cardholders and proper bussing.
1. Panelboards shall comply with the latest versions:
 - a. NEMA – PB1.
 - b. UL – 50 and 67.
 - c. CEC/NEC.

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- d. ASTM-B187.
 - 2. Where indicated on the Drawings shall be furnished with subfeed breakers and/or additional conductor lugs, split bussing, contactors, time switches, relays, etc., as required.
 - a. Branch circuit panels up through 42-circuits shall be single Section, to accommodate all of the circuits and components.
 - b. Distribution panels shall be single Section or Multi-Section, to accommodate all of the circuits and components.
 - 3. Panels shall be "Service-Entrance" equipment rated when the panel main incoming supply feeder originates from one of the following:
 - a. Originates outdoors exterior of the building in which the respective panel is located.
 - b. Originates from an electrical supply source not located in the same building as the respective panel.
- B. Housing and Painting, Panels and Terminal Cabinets
- 1. Shall be finished with one coat of rust inhibitor zinc chromate and coat of primer sealer after a thorough cleaning.
 - 2. Finish color paint as selected by District's Representative where exposed to public view (e.g., corridors, covered passages, offices, etc.). Prime coated panelboard shall be painted to match surroundings after installation in public areas.
 - 3. Manufacturer's Standard color in electrical rooms/closets, janitors, HVAC and storage rooms.
 - 4. Shall be fabricated of sheet steel of the following minimum gauges.
 - a. Full height hinged, locking door. Trim #12 gauge steel; enclosure - Code gauge steel.
 - b. Panels installed in indoor dedicated electrical equipment rooms and dedicated electrical equipment closets, omit full height hinged locking panel door. Dead front cover behind omitted panel door shall remain.
 - 5. NEMA-1 Metal Housing, for indoor locations.
 - 6. NEMA-3R Metal Housing, tamper resistant, for outdoor locations.
 - 7. Furnish all panels and terminal cabinets with the Manufacturers flush locks and keys except where indicated otherwise herein. Keys and locks shall be interchangeable for all panels. Provide two latches and two locks for door heights exceeding 36-inches.
 - 8. Fasten the trim to panel and terminal cabinets by means of concealed, bolted or screwed fasteners accessible only when the door is open.
- C. Panels 208/120 volt, 3-phase, 4-wire, S/N or 120/240 volt, single phase, 3-wire, S/N. Branch Circuit panel as manufactured by:
- 1. Square D "NF/NQ" Series
- D. Distribution Panels as manufactured by:
- 1. Square D "I-Line" Series
- E. Top and bottom gutter space shall not be less than 6-inches high. Provide 6-inches additional gutter space in all panels where double lugs are required, or where cable ampere size exceeds bus ampere size. Provide 12-inches additional gutter space in all panels for aluminum feeders where used.

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F. Panel Dimensions.

1. Panels with buss sizes 50-amp thru 400-amp.
 - a. Shall be 20-inches wide. Surface or flush mounting as indicated.
 - b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
 - c. Depth shall be 5.75-inches nominal. Height of panel as required for devices.
2. Panels with buss sizes greater than 400 amp.
 - a. Narrow panels 24-inches (maximum) wide by 6.5-inches (maximum) deep units. Wide panels 25-inches to 44-inches (maximum) wide by 8-inches to 15-inches (maximum) deep units. Nominal 90-inch panel height.
 - b. The wider units shall be used only at locations where the narrow unit is not available with the quantity or size of large-ampere frame branch/subfeed circuit protective devices shown on the panel schedules, or where the main breaker size exceeds the narrow panel maximum.
 - c. Distribution panels shall be floor standing and also supported from behind the panels at walls.

G. Distribution Panels and Branch Circuit Panels Maximum Load Rating

1. Panelboards and Distribution Panels exceeding 800-amp load rating shall not be permitted.
2. Provide Distribution Switchboards instead of Distribution Panels for bus load and circuit load ratings exceeding 800-amp.

H. Panel Auxiliary Cabinets

1. Panelboards shown on the Drawings with relays, time clocks or other control devices shall have a separate auxiliary metal barrier compartment mounted above panel.
2. Panelboards with circuits controlled by low voltage remote control relays shall be provided with separate auxiliary cabinets to contain the relays, adjacent to the panelboard.
3. Provide auxiliary cabinets with separate hinged locking door to match panel-board.
4. Provide mounting subbase in cabinet for control devices and wiring terminal strips.

I. Panels shall have a circuit index cardholder removable type, with clear plastic cover. Index card shall have circuit numbers imprinted to match circuit breaker numbers.

1. The panel identification nameplate shall describe the respective panel name and voltage, corresponding to the Contract Documents.
2. The electrical power source, name and location of each panel supply-feeder and supply equipment name shall also be identified and described on the respective panel nameplate.

J. Seismic Earthquake and Wind Loading Withstand, Testing and Certification (Additional Requirements)

1. The complete panel/panelboard assembly; including circuit protection devices, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested for Wind Loading and Earthquake Seismic Withstand.
2. Shall Withstand, survive and maintain continuous non-interrupted energized operation (running) during the seismic event occurrences. Continued normal

energized operation after the wind event and seismic event occurrences have abated.

3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation.
4. Provide three dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading as follows:
 - a. 110MPH – West Coast States USA and Hawaii, per ASCE/SEI 7-10.
5. Acceptance Test Seismic Qualification of proposed panels and panelboards shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
6. Seismic test shall be performed by a third party independent Test Laboratory. Wind Analysis and Seismic Testing and Reports shall be certified, signed and "Stamped" by PE Professional Engineer Licensed and in good standing in the State, Civil Engineer or Structural Engineer.

2.02 SHORT CIRCUIT RATING

- A. Circuit protective devices and bussing as indicated on the Drawings. All devices and bussing shall have a short circuit fault withstand and interrupting capacity not less than the maximum available fault current at the panel and as indicated on the Drawings, plus a 25% additional capacity (safety margin). However, in no case shall the short circuit fault interrupting and withstand capacity be less than the following symmetrical short circuit.

	<u>C/B and/or Bus Rating</u>	<u>Circuit Voltage</u>	<u>Short Circuit Amp.</u>
1.	400A and less	240V and below	10,000A
2.	400A and less	over 240V and below 600V	14,000A
3.	Over 400A & 800A & below	240V and below	42,000A
4.	Over 400A & 800A & below	over 240V and below 600V	30,000A

- B. Panel Short Circuit Fault Rating

1. General
 - a. Provide a "fully rated" for short circuit fault interrupt and full load ampere main circuit breaker in each branch circuit panel and/or each distribution panel. Provide the main circuit breaker whether or not a main circuit breaker is shown otherwise on the Drawings, Schedules or Diagrams. The "utility-source" plus the "motor-load" transient contributions shall be used to establish the available fault duty values, unless indicated otherwise on the Drawings.
 - b. The panel main circuit breaker full load ampere capacity rating shall equal the respective panel main bus ampere rating.
 - c. The panel assembly, buss and circuit protection devices bolted fault short circuit withstand and bolted fault short circuit interrupt ratings shall not be less than 125% greater (including a 25% safety margin) than the available utility-source symmetrical and asymmetrical bolted fault short circuit current when "Series Combined Rated" with the panel main circuit breaker.
 - d. The main circuit breaker rated "bolted-fault" short circuit fault interrupt and withstand short circuit rating shall not be less than 125% (including a 25% safety margin) of the upstream main service entrance "bolted-fault" available (symmetrical and asymmetrical) short circuit current.

2. Distribution Panelboards
 - a. Distribution panel, main circuit breaker, all feeder circuit breakers, and all branch circuit breakers shall be "fully-rated" (plus safety margin) for the available bolted fault short circuit current (including safety margin).
 - b. Shall provide time/current-tripping coordination with downstream equipment and upstream equipment.
3. Non-emergency branch circuit panelboards 400-amp buss and smaller; Non-emergency branch circuit panelboards 400-amp trip main circuit breaker and smaller.
 - a. The branch circuit panel main circuit breaker shall be "fully-rated" (plus safety margin) Current Limiting Circuit Breaker type (CLCB). Shall provide time/current- tripping coordination with upstream equipment.
 - b. The branch circuit panel main circuit breaker shall be "series-rated" with the panel downstream branch circuit devices and panel bussing. "The series-rating" shall provide short circuit bolted fault current withstand protection and short circuit bolted fault interrupt rating protection during a downstream 3-phase line-to-line and/or single-phase line-to-ground short circuit bolted faults.
 - c. Typical for branch circuit panelboards connected to normal-power (non-emergency) power circuits.
4. Emergency branch circuit panelboards 400-amp bus and smaller; Emergency branch circuit panelboards 400-amp trip main circuit breaker and smaller.
 - a. The branch circuit panel main circuit breaker shall be short circuit bolted fault "fully-rated" (plus safety margin) Non-Current Limiting Circuit Breaker type (non-CLCB).
 - b. The panel bussing shall also be short circuit bolted fault "fully-rated".
 - c. All of the branch circuit panel, branch circuit breakers shall be "fully-rated" Non-fused Current Limiting Circuit Breaker Type (CLCB). Shall provide short circuit bolted fault interrupt rating. Coordinated time/current and instantaneous tripping with the upstream circuit protection devices.
 - d. Typical for branch circuit panelboards connected to emergency power circuits.

2.03 PANEL CIRCUIT BREAKERS, CIRCUIT PROTECTION DEVICES

- A. Circuit Breakers General, for Distribution Panels and Panelboards
 1. NEMA-AB1 and AB3, comply with latest revision.
 2. UL-1087, UL-489 and IEC-60.947.2 rated devices, comply with latest revision.
 3. 5Hz AC closing and 3Hz AC trip and clear.
 4. Main circuit breakers for distribution panels exceeding 400 amp and larger;
 - a. Shall be Insulated Case Circuit Breaker type (ICCB).
 5. Main circuit breakers for branch circuit panelboards 400 amp buss and smaller;
 - a. Shall be Current Limiting Circuit Breaker type (CLCB) for non-emergency panelboards.
 - b. Shall be Molded Case Circuit Breaker type (MCCB) for emergency panelboards.
 6. Branch circuit breakers and feeder circuit breakers smaller than 100-amp trip shall be Molded Case Circuit Breakers type (MCCB) and/or Current Limiting Circuit Breakers type (CLCB).
 7. All circuit breakers 100-amp and larger trip shall employ sensors and solid state digital electronic automatic trip system. Short-time and long-time time/ current curve shaping field adjustable functions and adjustable instantaneous

trip. Typical for Molded Case Circuit Breaker type (MCCB), Insulated Case Circuit Breaker type (ICCB) and Current Limiting Circuit Breaker type (CLCB).

B. Manufacturer

1. Circuit breakers as manufactured by the following Companies only are acceptable:
 - a. Square D Co.

C. Configuration

1. Circuit breakers shall be arranged in the panels so that the breakers of the proper trip settings and numbers correspond to the numbering in the panel schedules on the Drawings.
2. Circuit numbers of breakers shall be black-on-white micarta tabs or other previously approved method. Circuit number tabs, which can readily be changed from front of panel, will not be accepted. Circuit number tabs shall not be attached to or be a part of the breaker.
3. Panelboard circuit protection devices shall be bolt on type for connection to panel bus. Removable and installable without disturbing adjacent devices.
4. Provide conductor wire terminations (lugs) on each circuit protection device for incoming main feeder, branch circuits and outgoing feeder circuits. Dual rated copper/aluminum and compatible with the respective conductor size, type, and quantity.
5. Where 2-pole or 3-pole breakers occur in the panels, they shall be common trip units. Single pole breakers with tie-bar between handles will not be accepted.
6. Branch circuit panels shall be field convertible for bottom entry main incoming feeder or top entry main incoming feeder.
7. Each Panel Section, the feeder and branch circuit protection devices (3-phase and/or 1-phase) shall be "twin-mount", side-by-side double row construction for the following circuit sizes:
 - a. 480/277 volt, 60-amp circuit size and smaller.
 - b. 240 volt – 208/120 volt, 100-amp circuit size and smaller.

D. Lock-Off and Lock-On

1. All circuit breakers shall be pad-lockable in the "off" position.
2. Where branch circuit breakers supply the power to motors and signal systems, the breakers shall also be furnished with lockout clips, mounted in the "on" position. The breakers shall be able to trip automatically with lockout clips in place.
3. Provide lock-on clips on branch circuit breakers supplying fire alarm equipment and fire alarm panels. Provide identification of the dedicated "fire alarm" circuit function and operation. Color-code the circuit breakers to comply with AHJ Requirements.
4. Locking facilities shall be riveted or mechanically attached to the circuit breaker (submit sample for approval. Other means of attachment shall not be accepted without prior written approval of the District's Representative.

E. ARC Fault Interrupter Circuit Breaker (AFCI-C/B)

1. AFCI-C/B provides automatic circuit interruption upon detection of any of these conditions: overload, short circuit fault and electric branch circuit arcing protection.
2. The AFCI-C/B shall detect intermittent "arcing" type electrical faults, and provide automatic circuit interruption (tripping).
3. Provide "test-pushbutton" on each C/B for manual AFCI-C/B testing.

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4. Single pole, 120-volt, 60Hz AC UL listed and labeled for installation in panelboard, #14 - #8AWG solid/stranded AL/CU load conductor.
- F. Switch and Fuse Feeder Protective Devices for Distribution Panels
1. Locations where the Drawings show distribution panels employing switch-fuse circuit protection devices.
 2. Fusible Switches: Quick-make, quick-break type with rejection clips for use with Class "R" fuses Current Limiting Fuses (CLF). Switches with ratings up to and including 100-amp at 240 volts shall be twins mounted. Switches rated through 60 amp and 480 volts shall be twins mounted. Provisions for padlocking in the "on" and/or "off" position. Switches shall be removable from front of panel without disturbing adjacent units or panel bus structure.
 3. Fuses shall be time delay current limiting types, UL Class RK-1 unless otherwise indicated on the Drawings. Provide one spare set of fuses of each size and type in each Distribution Panel.
 4. Provide auxiliary contact on switch for remote status (on-off) signaling and monitoring. Provide conductor lugs to accept conductor temperature rating, sizes and quantities shown on Drawings.
 5. Switch and fuse devices shall be permitted only in distribution panels and only where specifically indicated on the Drawings for feeders.

2.04 PANEL BUSSING

- A. Bus Material
1. Bussing shall be rectangular cross section tin-plated copper or alternately silver or tin-plated aluminum.
 2. Bussing shall be non-tapped, full length of the enclosure.
- B. Ground Bus
1. Each panel shall be equipped with a ground bus secured to the interior of the enclosure. The bus shall have a separate lug for each ground conductor. No more than one conductor shall be installed per lug.
- C. Provisions
1. Provide space and all hardware and bus mounting attachments for future devices as indicated on the Drawings.
- D. Neutral Bus
1. The ampere rating of the neutral bus of panels and distribution panels shall be a minimum of 100% greater ampere capacity than the ampere rating of the corresponding phase bus, where the panel is indicated to be provided with an "oversize-neutral" or "200%" neutral on the Drawings.

2.05 TERMINAL AND AUXILIARY CABINETS

- A. Cabinets
1. Fabricated of Code gauge sheet steel for flush mounting (except where noted as surface) of size indicated on the Drawings, and complete with hinged lockable doors, provide the quantity of 2-way Feed through conductor terminals required for termination of all conductors, plus 15% spares of each type.
 2. Cabinet locks to operate from same key used for panelboards. The trim to cabinets shall be fastened by means of concealed bolted or screwed fasteners accessible behind door into cabinets. All cabinets shall have $\frac{5}{8}$ -inch plywood

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- backing, finished with fireproof intumescent primer and finish coat paint. Provide equipment ground bus in each cabinet.
3. Cabinets shall be finished with one coat of zinc chromate and one coat of primer sealer after a thorough cleaning. Where exposed to public view (e.g., corridors, covered passages, offices, etc.) finish color paint to match surrounding and Manufacturer's standard gray color in switchboard, janitors, heater and storage rooms.
 4. Provide grounded metal barriers inside cabinet to isolate and separate line voltage and low voltage from each other inside the cabinet.
- B. Cabinet Dimensions.
1. Unless indicated otherwise on Drawings.
 - a. Shall be 20-inches wide. Surface or flush mounting as indicated.
 - b. Recess mounted type shall have a 20-inches wide (maximum) recess metal enclosure with overlapping edge trim plate cover extending 1-inch on all sides of enclosure.
 2. Depth shall be 5.75-inches nominal. Height of cabinet as required for devices, plus 25% spare unused interior space for future use, but not less than 36-inches high.
- C. Terminals
1. Non-digital analog circuits; line and low voltage modular signal systems, 15-amp dual row with isolation barriers, screw-down terminals insulated strips, heavy duty.
 - a. As manufactured by Molex, or ITT-Cannon, or General Electric.
 2. Digital circuits; low voltage signal systems, ANSI/EIA/TIA Category-6, 110-Block or 66-Block gas-tight punch down style, heavy duty.
 - a. As manufactured by: Leviton, or Ortronics, or AMP.
- D. Identification (additional Requirements)
1. Provide engraved nameplate on each cabinet indicating its designation and system (i.e., "Life Safety System - Panel 2LS", etc.).
 2. Identify each terminal landing with unique circuit number and provide corresponding alphanumeric text-index card inside panel access door

PART 3 EXECUTION

3.01 MOUNTING

- A. Flush Mounted Panelboards and Terminal Cabinets shall be securely fastened to at least two studs or structural members. Trim shall be flush with finished surface.
1. Panels and cabinets installed flush (recess or semi-recess) into fire rated or smoke rated walls. The wall recess shall be fully wrapped inside the recess with fire/smoke rated materials. The wrap-materials shall provide the same fire and/or smoke protection rating as the respective wall.
- B. Surface Mounted Panels and Terminal Cabinets shall be secured to walls by means of preformed galvanized steel channels securely fastened to at least two studs or structural members.
- C. Panelboards and Terminal Cabinets shall be installed to insure the top circuit protective device (including top compartment control devices) are not more than 6-feet-6-inches above finish floor in front of the panel and the bottom device is a

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minimum of 12-inches above the floor. Manufacturer shall specifically indicate on Shop Drawing submittals each panel where these conditions cannot be met.

3.02 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

- A. Provide a red and white Bakelite nameplate with $\frac{1}{2}$ -inch high letters in each 277/480 volt panel fastened to face of dead-front plate, to read: "DANGER 480 (or as applicable) VOLTS KEEP OUT AUTHORIZED PERSONNEL ONLY".
- B. Manufacturer shall stencil the panel/cabinet number identification on the inside of door to correspond with the designation on the Drawings.
- C. Identification Plates and Numbers shall be attached with screws or twist lock fasteners. Adhesive attachment of any kind shall not be used.

3.03 SPARE CONDUITS (ADDITIONAL REQUIREMENTS)

Provide three 1-inch conduit only stubs from each panel and terminal cabinet into accessible ceiling space. Where floor level below panel or terminal cabinet is accessible, also provide an additional three 1-inch conduit only stubs into accessible floor space.

END OF SECTION 26 2416
121619/223077

SECTION 26 3323

EMERGENCY LIGHTING CENTRAL BATTERY

PART 1 GENERAL

1.01 SCOPE

- A. Work Included: All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section, complete as shown on the Drawings and/or specified herein. Work includes, but is not necessarily limited to the following:
 - 1. Examine all other Sections for work related to those other Sections and required to be included as work under this Section.
 - 2. General Provisions and Requirements for electrical work.
- B. Demonstration and Instruction (Additional Requirements)
 - 1. Provide on-site instruction classes and operation manuals to the District's Personnel.

1.02 SUBMITTALS (ADDITIONAL REQUIREMENTS)

- A. General
 - 1. Submit Manufacturer product data, dimensional data, ambient environmental data and derating factors, electrical performance data.
 - 2. Submit performance and technical information on battery calculations and/or factory tests demonstrating capacity capabilities.

1.03 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

- A. General
 - 1. The equipment shall be listed, labeled and approved for the application show in the Contract Documents, as a battery stored energy, emergency lighting electrical power inverter, complying with the most recent version of the following Applicable Standards.
 - 2. The following standards shall become Requirements of Contract Document and are included in the Contract Documents.
- B. Underwriters Laboratory – UL
 - 1. UL – 924 and 924A Standard for Emergency Lighting and Power Equipment.
 - 2. UL – 1778 Standard for Uninterruptible Power Supply Equipment.
- C. National Fire Protection Agency – NFPA
 - 1. NFPA – 111 Stored Electrical Energy and Standby Power systems.
 - 2. CEC – Article 700 Emergency Systems (CEC) Article 480 Storage Batteries.
- D. Federal Communications Commission – FCC
 - 1. FCC - Class A RFI emission limits.
- E. American National Standards Institute – ANSI
 - 1. ANSI – C62.41 Both Category-A and Category-B and C62.45 Transient Voltage Withstand.

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- F. Institute of Electrical and Electronic Engineers – IEEE
 - 1. IEEE – 587 Surge Voltages
- G. Seismic Earthquake and Wind Loading Withstand, Testing and Certification (Additional Requirements).
 - 1. The complete emergency lighting central battery inverter assembly; including circuit protection devices, meter, housings/enclosures, batteries, accessories, supports/anchors etc., shall be designed, manufactured, and tested.
 - a. Wind loading all outdoor equipment locations.
 - b. Earthquake Seismic Requirements of CBC Seismic withstand all indoor and all outdoor equipment locations.
 - 2. Shall withstand, survive and maintain continuous non-interrupted energized operation during the seismic event occurrences and wind event occurrences. Continued normal energized operation after the wind event and seismic event occurrences have abated.
 - 3. Shall include demonstrations of successful operation and run test after completion of seismic event shake-table simulation. Acceptance Test Seismic Qualification of proposed equipment shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
 - 4. Provide three dimensional finite element analysis demonstrating anchorage and operational withstand of wind loading not less than as follows and as required by AHJ:
 - a. 110MPH-West Coast States USA, California, and Hawaii, per ASCE/SEI 7-10.
 - 5. Seismic test shall be performed by a third party independent Test Laboratory, shall include batteries. Wind analysis and Seismic Testing and Reports shall be certified, signed and “Stamped” by PE Professional Engineer licensed and in good standing in the State, Civil Engineer or Structural Engineer.
- H. Short Circuit, Coordination and Arc-Flash (Additional Requirements)
 - 1. Perform and submit short circuit fault current, time/current coordination and Arc-Flash fault engineering analysis, for AC and DC circuits.
 - 2. Provide label equipment with warning and instructional signs.

PART 2 PRODUCTS

2.01 OPERATION

- A General
 - 1. The Emergency Lighting Battery Unit (ELBU) shall be self-contained, automatic operation. Unit shall store electrical energy and supply standby back-up electrical energy upon failure of normal (utility source) power and provide operation of lighting and other connected equipment as described in the Contract Documents.
 - 2. ELBU shall consist of an automatic circuit transfer system, input/output circuits, storage batteries, battery charger, voltage inverters, monitoring, test/monitoring equipment and operating program software. Manufactured with all components enclosed in modular cabinetry.
 - 3. ELBU volt-ampere continuous load rating shall be sufficient to provide operation of the full unit rated load. But in no case less, than required to supply all of the connected loads shown on the Drawings, plus an additional

20% spare continuous load capacity "Safety Factor". All at an 80% lagging load power factor.

- a. Normal mode load capacity operation duration shall be continuous.
 - b. Emergency mode full 100% rated load capacity operation shall be for the duration time indicated on the Drawings, but not less than 90 continuous minutes.
 4. Unit shall operate properly in ambient temperatures from 15 to 25 degrees centigrade, sea level to 10,000 feet above sea level, at the specified ratings.
 5. Emergency lighting central battery unit shall be as manufactured by Dual-Lite; or Myers Power Products.
- B. Operation
1. During operation under normal mode 60Hz AC power, the supply voltage shall feed both the output load and the battery charger. Upon normal power failure, the output load shall be automatically transferred to internal 60Hz AC emergency mode power operation.
 2. When normal power is re-established, the output load shall be automatically transferred back to the normal power AC line and the charger shall commence recharging the batteries to their full capacity.
 3. Transfer to emergency mode operation shall occur when normal input voltage drops to less than 60% to 70% of nominal for brownout protection on any input line phase. The transfer to emergency mode shall also occur if there is an open circuit, or shorted circuit on the normal input side. A 15 to 60-second transfer time delay (nominal) back to normal mode operation shall be adjustable to reduce "cycling" operation between normal and emergency operating modes.

2.02 LOAD REQUIREMENTS

- A. Load Types
1. Load output shall be provided for the following types of loads in any loading combination (0 to 100% of load rating), within the rated capacity (0 to 100% of load rating) for 50% lag through 50% lead load power factors.
 2. Unit shall be suitable for operation and withstand inrush currents associated with the connected loads without damage or changes in its operation including:
 - a. Incandescent lamps and ballasts.
 - b. Fluorescent lighting fixtures and ballasts.
 - c. Electronic equipment including fire alarm equipment.
 - d. High Intensity Discharge (H.I.D.) lighting fixtures and ballasts (continuous Arc-sustain operation).
 - e. Solid state electronic lighting fixture ballasts and dimmers.
 - f. Electromagnetic lighting fixture ballasts and dimmers.
 - g. LED (Light Emitting Diode) solid-state lamps and drivers.
 - h. Fire door holds open devices.
- B. Voltage
1. Normal power input and output voltage shall be 60Hz, AC single phase or three phase; 120 volt; 208 volt; 240 volt; 277 volt; 120/208 volt 3 wire or 120/240 volt 3 wire. All as indicated on the Drawings.
 2. Provide multiple load output voltages, for both normally on and normally off loads, where indicated on the Drawings (i.e., 120-volt input - 120 volt and 277-volt load output; 277 volt input-120 volt and 277 volt output; etc.).

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3. The total line input volt-amperes shall not exceed 135% of the unit rated full load output volt amperes and output line voltage, including battery-recharging loads.
- C. Circuit Breakers Line and Load
1. Provide load output circuit breakers, ampacity and quantity as indicated on the Drawings, but in no case less than one 20-amp load output circuit breaker for each 1500 volt ampere (or portion thereof) of unit rated load capacity. Provide the circuit breakers on each normally off and each normally on load out connection and on each load out voltage connection.
 2. Provide a unit main line input circuit breaker in the ELBU. The circuit breaker shall be sized to allow continuous full rated load operation of the ELBU, including battery-recharging loads.
 3. Provide D.C. battery protection internal breakers.
 4. The circuit breakers shall be thermal magnetic molded case type. The Main line input circuit breaker shall be rated a minimum of 42,000-amp symmetrical short circuit interrupting capacity, but not less than shown on the Drawings. Internal and load output circuit breakers shall be "series rated" or "fully rated" to the main input circuit breaker symmetrical short circuit interrupting capacity, at the specified input and output voltage(s).
 5. Monitor and trouble-alarm each circuit breaker for "tripped" or "off" condition.
- D. Load Output
1. Provide output load types as follows (in any combinations up to unit full rated output capacity).
 2. Normally on - Output load is energized in both the normal and emergency modes.
 3. Normally off - Output load is energized only when unit is in the emergency mode and de-energized when the unit is in the normal mode.
 4. The unit shall function correctly with no load (zero-volt amp) connected to the output terminals. UNITS REQUIRING A MINIMUM CONNECT LOAD FOR CORRECT OPERATION ARE NOT ACCEPTABLE.
- E. Load Output Voltage Characteristics
1. During the entire rated operation duration, output voltage shall be sinusoidal wave.
 - a. Total harmonic distortion shall not exceed 5% under any combination of the specified load conditions.
 - b. Voltage regulation shall not vary more than plus or minus 5% of rated volt-age under all load conditions, no load 0% to 100% of full rated load.
 2. Load output voltage frequency regulation shall be within plus or minus 0.5Hz under specified load conditions, when operating on the inverter and batteries.
- F. Efficiency When Operating In Any Mode
1. At 100% rated load – greater than 97%.
 2. At 50% rated load – greater than 94%.
 3. Efficiency shall be measured load output kW divided by the measured line input kW; with a connected load power factor of 0.8 lagging and the batteries fully charged operating on trickle float charge.
- G. Internal Bypass Switch
1. Switch shall keep all of the loads circuits energized while the ELBU is shut down (bypass) due to malfunction or maintenance.

2. Three position switch: normal; unit bypass; loads off.

2.03 INVERTERS

- A. General
 1. Inverters shall be modular and completely solid state. Protected against over-loads, in rush loads and short circuits.
 2. Inverter shall provide stable regulated output operation from the internal batteries under all specified load conditions.
 3. Low battery voltage cutout shall be provided to disconnect the inverter load when the battery output voltage drops below a preset value.
 4. Automatic unit restart after initiation and/or restoration of normal input power.

2.04 CONTROL, TESTING AND MONITORING EQUIPMENT

- A. Internal Control, Monitoring and Testing with Programming Software and Micro-processor Control Operation shall be provided to verify proper system operation and trouble conditions. Control, testing, and metering display panel shall be installed in the door of equipment cabinet not more than 6-feet-0-inches above finished floor.
- B. System Display/Control Panel
 1. The system's display panel shall include an array of visual indicators, multi-line alphanumeric character display, and a keypad to control and monitor the system.
 2. The array of visual indicators shall monitor and annunciate the AC utility presence, system ready status, battery charging status, battery emergency operation, and alarm functions.
 3. The system shall display alphanumeric meter functions including:
 - a. Input-voltage and input demand load.
 - b. Output-voltage, output-frequency, output-demand load and output-power factor.
 - c. Unit internal component temperatures.
 - d. Total quantity of power outages and inverter operating time.
 4. To ensure only Authorized Personnel can operate the unit, the system shall be password protected for all control functions, including parametric changes.
- C. Alarms
 1. The system shall have audible and alphanumeric visual alarm display, with automatic logging of the twenty most recent alarm events. Each alarm will have a corresponding audible signal associated with it to aid in the troubleshooting of the system.
 2. The system's alarm acknowledge feature shall enable the user to silence only the current audible alarm(s), while not silencing other alarms and not clearing the alarming condition until the fault has been cleared.
 3. Alarms shall monitor low, near low, and high battery voltage; high AC voltage input; high and low AC voltage output; volt-amp output overload; low runtime remaining; high ambient component temperature over limit; check charger, battery, inverter, and memory/logic; emergency power off activated; user test check; and call service.
 4. Alarms on each internal circuit breaker, to indicate when the circuit breaker is in the open/off/tripped positions.

- D. Manual and Programmable Testing**
 - 1. The system shall provide both manual test functions and software programmable automatic test modes. The user shall be able to perform a system test at any time.
 - 2. The system shall also perform an automatic programmable, weekly, self-diagnostic test and load test of its subsystems to insure the system will operate in an emergency condition. A monthly load test for a user programmable discharge time and an annual test for a complete runtime discharge time and an annual test for a complete runtime discharge.
 - 3. Automatic recording in memory, of the last twenty inverter events, including all automatic weekly and user programmed tests, shall be logged.
- E. Remote Terminal Strip**
 - 1. An auxiliary terminal strip located within the system cabinet shall provide connection points for remote monitoring of inverter status and alarm indication.
 - 2. Remote monitor/annunciator panel:
 - a. Provide a remotely mounted ELBU monitoring/alarm panel, with operating status and alarm conditions visual and audible indicators. Provide an audible alarm silence push-button with automatic resound on subsequent alarms.
 - b. The panel shall be enclosed in a NEMA 1 for indoor locations, NEMA 3R for outdoor locations. Flush mounted housing, with "see-thru" front cover access door. Tamper resistant construction, suitable for installation in unsupervised public areas.
 - c. The remote monitoring and alarm panel shall operate over connecting circuit lengths up to not less than 300-foot distance from the respective ELBU.
 - d. Provide remote monitoring and alarm panels adjacent to each fire alarm annunciator panel unless noted otherwise on the Drawings.

2.05 BATTERIES

- A. General**
 - 1. Batteries shall provide capacity to operate the unit and maintain specified inverter output for indicated years on a pro-rata basis when properly maintained as recommended by the Manufacturer.
 - 2. Flame arresting caps shall be provided on batteries, with catalytic conversion to prevent hydrogen out gassing.
 - 3. Battery cases shall be translucent to allow visual observation of electrolyte level. Provide earthquake restraint battery mounting straps.
- B. Battery Seismic Restraint**
 - 1. Batteries shall be installed in the unit with seismic restraint anchors and straps.
- C. Battery Type**
 - 1. Batteries shall be nickel cadmium low maintenance type to reduce the need to replenish battery fluids. Batteries shall be 25-year design life expectancy at 77-degrees Fahrenheit ambient, pocket plate construction. Maximum battery discharge shall be automatically limited to the value recommended by Battery Manufacturer of nominal battery voltage, with full rated unit out-put during discharge.

2.06 BATTERY CHARGER

- A. General
 - 1. Battery charger shall be solid state specifically designed for the type of batteries used in the system.
 - 2. Battery charger shall have automatic protection against short circuits, low battery condition, DC-over voltage protection and protected against thermal runaway.
 - 3. Charger shall automatically maintain correct battery charge conditions, with float charging and periodic equalize battery charges, within plus or minus 0.05 volts of Battery Manufacturer's recommendations.
 - 4. The charger shall completely restore fully discharged batteries from the input line source, to full battery charge condition in less than 24 hours.

2.07 CABINET

- A. General
 - 1. The cabinetry shall contain all components, inverter, transformers, power supplies, battery charger, including the batteries, free standing with hinged locking door. All components shall be accessible from the front for maintenance and removal.
 - 2. Units requiring side access for cooling air or maintenance shall not be acceptable unless the Drawings specifically show the permitted side access space provisions.
 - 3. Provide water shields on cabinets, to protect the ELBU from fire sprinkler discharge water damage.
- B. Cabinet Construction
 - 1. The cabinets shall be metal, NEMA 1 enclosure, equipped with a key-operated access lock.
 - 2. Manufacturer's standard finish color with rust inhibitor "primer" and acid-resistant finish paint.
 - 3. Battery shelves shall permit the batteries to be tested or have battery fluids added without having to remove the batteries.
 - 4. The doors shall open full without affecting the operation of the unit. Conduit knockouts shall be provided on both sides, bottom and top of the cabinet for connection of line and load circuits. Provide dead front or insulated covers over exposed energized parts to prevent accidental contact, when doors are open.
- C. Electrical Connections
 - 1. Provide line and load terminal lugs and identification tags on all circuits.
- D. Size
 - 1. Maximum cabinet size including batteries shall not exceed those shown on Drawing, but in no case larger than as follows:
 - a. Up to 4600VA at 80% power factor rated load output: 43-inches wide by 84-inches high by 21-inches deep.
 - b. 4601VA to 11000VA at 80% power factor rated load output: 85-inches wide, by 84-inches high by 24-inches deep.
 - c. 11001VA to 17,500VA at 80% power factor rated load output: 128-inches wide by 84-inches high by 26-inches deep.

2.08 COMMUNICATION PORTS

- A. General**
 - 1. The ELBU shall provide a standard RS-232 Bi-Directional Serial Communications Port, for communicating with portable computers. Provide software with the ELBU for control, monitoring and diagnostic/maintenance operations of the ELBU. The software shall operate on Microsoft-Windows® based, PC style computers, using 3.5-inches "Floppy-Disk" magnetic storage media, or 5.25-inch "CD/DVD" ROM.
 - 2. The PC computer is not included in the Contract Scope of Work.
- B. Remote Monitoring and Control**
 - 1. Facsimile/Modem Communications Panel: Shall automatically transmit system's operating status reports over a dedicated "dial-up" telephone line to remote locations. Provide 1-inch conduit with (ANSI/EIA/TIA-568B) two Category-6, 4-pair, UTP cables and homerun to IDF/ MDF telephone terminal.
 - 2. Each designated location shall automatically receive a unit status reports transmission following all monthly and annual test cycles or when an alarm conditions is detected by the system's self-diagnostic electronics.
 - 3. Status reports shall be software programmable and include readings on key operating parameters as well as complete alarm and inverter log printouts.
 - 4. The ELBU Manufacturer shall provide 364 calendar days duration, remote monitoring and supervision of each ELBU. The start date shall begin from the Construction Contract substantial completion date, notice of completion. Provide not less than two written status reports, to the District's Representative, at 180 calendar days and 330 calendar day mile-stones.
 - 5. The District and Manufacturer shall have the option to renew the Manufacturer's Monitoring Control Contract at a negotiated fair market price and terms, at the end of the initial 364 calendar day periods.
- C. Monitoring and Communications Circuits**
 - 1. Provide monitoring and communication circuits as follows:
 - a. One 0.75-inch conduit, homerun from each ELBU to nearest telephone/ data terminal back-board, with two EIA/TIA-568C Category-6A 4-pair UTP communication cables in conduit.
 - b. One 0.75-inch conduit, homerun from each ELBU to Building Automation System (BAS) communications transponder, with two EIA/TIA-568C Category-6A, 4-pair UTP communications cables in conduit.

PART 3 EXECUTION

3.01 TESTING

- A. General**
 - 1. All units and batteries shall be inspected for damage as soon as they are received. Specifically check to see if wet cell batteries have been turned over in shipment and whether the equipment cabinets have received any severe dents which might cause internal damage. Remove and replace all damaged equipment with new undamaged equipment.
 - 2. Use only the factory provided knock-out areas and conduit entry provisions on the equipment for wiring. Care shall be taken not to let metal slugs or chips get into the equipment cabinet.

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3. Prior to energizing equipment, perform measurements on the incoming and load output AC lines to the equipment to insure that the proper voltage level is available and that there are no ground faults or high potentials between conductors or between phase conductor to neutral/ground.
 4. Prior to installing the fuses, or closing the circuit breaker in the battery circuit, verify correct battery voltage, polarity markings, battery electrolyte level and all electrical connections are secure.
 5. Prior to turning the system on for any tests, the unit shall be bypassed with the mains connected to feed the load directly and the currents in each conductor measured and balanced. Follow Manufacturer's instructions for installation, connection and energizing equipment.
 6. Batteries which are shipped with the electrolyte in the battery cells shall be maintained on a float charger when not installed and energized, operating the emergency power unit. Batteries shipped without electrolyte installed in the battery cells shall not have electrolyte added until equipment is installed and ready to be energized. Batteries which are not handled with this procedure will be rejected, shall not be used and shall be replaced with new batteries at the Contractors expense.
 7. Provide Factory Authorized Field Service Technician factory start-up to inspect, energize, test and certify the correct system installation, connections and operation. Provide written acceptance field service report, six copies, to District's Representative.
- B. Commissioning (Additional Requirements)
1. Setup, testing, startup, and Commissioning shall be performed by Factory Technician(s) trained, certified and authorized by the Equipment Manufacturer. Final Commissioning shall be performed after installation and connections are complete.
 2. Provide system programming and setup of all control sequences for the emergency/exit lighting control system.
 3. Simulate normal source power failure by opening (turn-off) building main service disconnect and verify connections and operation of each electrical system device connected to the system on both normal power source and emergency power sources. Simulated test time for operating duration connected on the emergency systems shall be not less than 90 continuous minutes without failure or anomalies in the system.
 4. Record and document electrical demand load and sequence of operations on the ELBU system with all connected loads operating, including but not limited to:
 - a. Fire alarms
 - b. Egress/exit lighting
 - c. Doors
 - d. Auto-loading and overload shedding controls
 5. Test all control system functions after the installation and connections are complete and the system has been energized. Verify each control sequence of operation and each device to be controlled are each operating correctly.
 6. Record and document each device setup and program setting.
 7. Submit written report (six copies) to District's Representative certifying Commissioning has been performed; all respective systems are operating correctly and document all software setup and each device setting.
 8. Refer to General Commissioning Section 01 9113 for Additional Requirements.

3.02 SEISMIC EARTHQUAKE

A. General

1. The entire unit shall be installed and anchored to building structure to comply with Seismic Earthquake Requirements.
2. Install seismic restraints on all batteries.

3.03 FACTORY SERVICE AGREEMENT (FIRST YEAR OPERATION)

A. General

1. Provide site visits and written reports for each ELUB at unit start-up, Commissioning and again approximately 12 months after completion of Testing and Commissioning. Shall be included as part of the Base Contract Scope.
2. Factory Authorized Technician shall test all ELUB options, accessories and functions, physical, Electrical and Mechanical inspection. Simulate normal source power outage and recharge functions.
3. ELUB factory remote monitoring and reporting of each ELUB status, using telephone communications line provided by the District.
4. The Base Contract initial first year Operation Service Scope shall be renewable, if mutual agreement between the ELUB Manufacturer and the District is accomplished for service cost, scope and renew.
5. Provide three copies of factory service proposal renew agreement to the District's Representative.

END OF SECTION 26 3323

121619/223077

SECTION 26 6010

ELECTRONIC NETWORK SYSTEMS INFRASTRUCTURE

PART 1 GENERAL

1.01 CODES AND STANDARDS COMPLIANCE

- A. TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises
- B. TIA-568-C.1 Commercial Building Telecommunications Cabling Standard
- C. TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- D. TIA-568-C.3 Optical Fiber Cabling Component Standard
- E. ANSI/TIA/EIA-569-C-2012 Commercial Building Standard for Telecommunications Pathways and Spaces
- F. ANSI/TIA/EIA-570C-2012, Residential and Light Commercial Telecommunications Wiring Standard
- G. ANSI/TIA/EIA-606B-2012, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- H. ANSI/TIA/EIA-607B-2011 Commercial Building Grounding and Bonding Requirements for Tele-communications
- I. ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers
- J. Building Industries Consulting Services, International (BICSI)Telecommunications
- K. Distribution Methods Manual (TDMM) – 12th Edition
- L. FCC Part 68
- M. National Fire Protection Agency (NFPA) - 70, National Electrical Code (NEC) - 2011.
 - 1. Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, fax: 303-397-2740, <http://global.ihs.com/>
 - 2. IEEE-Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY, 10017-2394, 800-678-IEEE, fax: 732-981-9667, <http://standards.ieee.org/>

1.02 ASSOCIATED REFERENCES:

- A. ISO/IEC 8802-3 (IEEE 802.3)
- B. ISO/IEC 8802-5 (IEEE 802.5)
- C. ANSI X3T9.5 Fiber Distributed Data Interface (FDDI) Physical Medium Dependent (PMD)

- D. ANSI X3T9.5 Twisted Pair Physical Medium Dependent (TP-PMD)

1.03 SYSTEM DESCRIPTION

- A. Backbone Pathway: Conform to EIA/TIA, using conduit as indicated.
- B. Horizontal Pathway: Conform to EIA/TIA, using raceway and cabinets as indicated.
- C. Backbone Cabling: Conform to EIA/TIA. Provide a combination of fiber-optic cable (both multi-mode and single mode), Category 6 cable, and for the backbone with quantities as indicated on the Drawings. See cable count section for detail number of cables. Provide a backbone cabling system complete from outlying buildings to the Main Distribution Frame (MDF) and from the MDF to all Intermediate Distribution Frames (IDF).
- D. Horizontal Distribution Cabling: Terminate using 568-B single-user enhanced Category 6, 4-pair UTP cables complete from each jack (there are multiple jacks per outlet) to the associated intermediate distribution frame. Unless indicated otherwise on Drawings, Each outlet will have a minimum of three each. Category 6 cables with RJ45 connectors at the IDF. All cables terminated to RJ45 patch panel.
- E. Distribution Frames: Install Chatsworth racks at all MDF and IDF locations. Space limitations may require installation of wall hung cabinets (requires pre-approval by Owner). Install all required patch panels, fiber termination panels, fiber couplers wire management, and connectors; at each of the MDF's and IDF's to complete the structured cabling system.
- F. Active Devices: Provided and installed by Owner.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01330.
- B. Shop Drawings: Include outlet and cabling labeling and identification scheme (Conforming to TIA/EIA-606A), floor plans indicating all outlets, racks and other associated equipment; all products with catalog cuts clearly identifying the product types and numbers; rack elevations showing all patch panels, wire management devices and space for all Owner supplied active devices; and all warranties.
- C. Test Documentation
 1. Test documentation shall also be presented in electronic format, PDF file preferred. The test equipment by name, Manufacturer, model number and last calibration date will also be provided at the end of the document. Unless a more frequent calibration cycle is specified by the Manufacturer, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test. Testing submittals for Manufacturer's warranty shall comply with Manufacturer's Requirements.
 2. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.
- D. Provide Detailed Documents indicating the proposed grounding scheme.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01770.
- B. Record actual locations and sizes of pathways and outlets.
- C. Mark Project Record Documents daily to indicate all changes made in the field.
 - 1. In addition to general Requirements of Project Record Drawings, indicate on Drawings, changes of equipment locations, alterations in raceway runs and sizes, changes in installation details, etc.
 - 2. Use red to indicate deletions and green to indicate additions.
 - 3. Use the same symbols and follow, as much as possible, the same drafting procedures used on the Contract Drawings.
- D. Locate underground conduit stubbed-out for future use, underground feeder conduits, and feeder pull box locations using building lines by indicating on the Project Record Drawings.
- E. The installation Contractor will obtain two set(s) of (D-) size Drawings at the start of the Project. One set will be designated for the central location to document all as-built information as it occurs throughout the Project. The central set will be maintained by the Contractor's Foreman on a daily basis, and will be available to the Architect/Owner upon request during the course of the Project. Anticipated variations from the Building Drawings may be for such things as cable routing and actual outlet placement. No variations will be allowed to the planned termination positions of horizontal and backbone cables, and grounding conductors unless approved in writing by the Owner. Contractor shall also redraw the Site and Floor Plans showing all fiber, copper, racks, and information outlets as well as the labeling scheme for all items. These Drawings shall be created using current versions of AutoCAD. A computer CD and the paper copies shall be turned over to the Owner with the O&M manuals.

1.06 QUALIFICATIONS

- A. The Telecommunications Contractor shall be an approved Leviton Certified Installer for at least 90 days prior to Project.
- B. The Owner reserves the right to require the Contractor to remove from the Project any such Employee the Owner deems to be incompetent, careless or insubordinate.
- C. All clean up activity related to work performed will be the responsibility of the Low Voltage Contractor and must be completed daily before leaving the site.

1.07 PRE-INSTALLATION CONFERENCE:

- A. Schedule a conference a minimum of 5-calendar days prior to beginning work of this Section.
- B. Agenda: Clarify questions related to work to be performed, materials to be used, scheduling, Coordination, etc.
- C. Attendance: Communications System installer, General Contractor, Architect, Owner's Representatives, and other parties affected by work of this Section.

1.08 WARRANTY

- A. Installation Warranty
 - 1. Provide Leviton system warranty covering the cabling system against defects in workmanship, components, and performance for "Lifetime" from the date of system acceptance. The warranty shall cover all labor and materials necessary to correct a failed portion of the system and to demonstrate performance within the original Installation Specifications after repairs are accomplished. This warranty shall be provided at no additional cost to the Owner.
 - 2. System shall be installed by an Authorized Leviton Installer with greater than 6 months of experience installing the system. The Leviton Authorized Installer must provide certificates of completion of the Leviton Certification Course for Technicians who will be installing the system.
- B. Cable System Warranty
 - 1. A Lifetime Performance Warranty covering all components, equipment and workmanship shall be submitted in writing with the system documentation. The warranty period shall begin on the system's first use by the Owner.
 - 2. The Project must be pre-registered with Leviton before installation has begun and final testing submitted per to Leviton in original tester format.
 - 3. Should the cabling system fail to perform to its expected operation within this warranty period due to inferior or faulty material and/or workmanship, the Contractor shall promptly make all required corrections without cost to the Owner.

1.09 REGULATORY REQUIREMENTS

- A. Conform to Requirements of NFPA 70.
- B. Furnish Products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of premises wiring for 1-year from Date of Substantial Completion.
- B. Installer will be notified of any defects in labeling and installation and a resolution to the problem is expected within 7 working days.

PART 2 PRODUCT

2.01 MANUFACTURER

Manufacturer shall be Leviton or Leviton approved partner. NO SUBSTITUTIONS WILL BE ALLOWED.

2.02 OUTLETS

2.03 EACH LOCATION WITH AN OUTLET SHALL CONTAIN NO LESS THAN 2 CAT6 CABLES. ADDITIONAL CABLES MAY BE SPECIFIED ON DRAWINGS

- A. Telecommunications and Data Outlet Connector Module: Jacks: Eight-wire, eight-position, modular, Termination of all connectors shall be 110-type insulation displacement connectors (IDC). The connector shall provide a ledge directly adjacent to the 110-style termination against which the wires can be terminated and cut in one action by the installation crafts-person. Connector wiring is universal and will accommodate installation color codes for T568A and T568B-wiring schemes. Leviton eXtremeTM 6+ (p/n 61110-RW6) (white). Match jacks to Category rating of attached horizontal distribution cable. Each jack shall be fed by a separate four pair cable sheath. All four pairs shall be wired to the data jack.
- B. Faceplates: Icon-able 110 connect faceplates. Color White. Provide a minimum of four ports. Use duplex mounting straps as required in floor box or surface raceway applications. All modular jacks shall be oriented with the locking tab slot towards the floor.
 - 1. Faceplate: Leviton Model #42080-6WP (white).
 - 2. Blank Inserts: Provide blank inserts in all unused ports. Leviton Model #41084-BWB (white).
- C. Faceplates for modular furniture to be supplied by Installer and coordinated with District for install during/after furniture install.
 - 1. Most modular furniture will use Leviton QuickPort Modular Furniture Faceplate, 4-port white #49910-HW4. Exact part # to be coordinated with District.

2.04 RACKS/CABINETS

- A. MDF Rack: Minimum two each 19-inches wide x 84-inches high x 24-inches deep, floor-mounted. Provide larger or multiple racks where required to accommodate all cables, cross connect hardware, and active devices. Chatsworth Universal Rack Part Number 48353-703. Color: Black.
- B. IDF Rack: Minimum one each 19-inches wide x 84-inches high x 24-inches deep, floor-mounted. Provide larger racks where required to accommodate all cables, cross connect hardware, and active devices. Chatsworth Universal Rack Part Number 48353-703. Color: Black.
- C. Cable Management:
 - 1. Horizontal Cable Management: Provide a minimum of two front wire management panels in each rack. One combination front and rear horizontal wire management shall be provided for each fiber termination box, for each 24 ports of RJ45 panels, and for each 24 ports of hubs or switches (p/n 49252-PCM). All racks shall be furnished with a minimum of 25 Velcro cable ties to ensure a neat and manageable system.
 - 2. Vertical Wire Management: Vertical wire management shall be supplied for all open racks. Vertical wire management shall be Chatsworth vertical management (six required per rack).
 - 3. Inter-bay/End-cap Cable Managers: Where required provide inter-bay and end-cap management panels. The inter-bay manager shall have integral routing and slack storage loops supporting a 1.5-inch minimum bend radius. Inter-bay and end-cap management panels shall be supplied with adjustable routing guides. Both inter-bay and end-cap units shall have removable covers secured

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with 1/4-turn fasteners. Inter-bay and end-cap cable managers shall securely attach to the rear rail of the rack with #12-24 screws. A cable trough shall be supplied at the bottom of each rack to support patch cord routing between racks.

- D. Ground Bus: Provide a TMGB ground bus at the MDF and a TGB ground bus at each IDF. B-line # SB-476, SB-477.
- E. Power Supply: Install an APC NET9RMBLK surge suppression power strip with a cord long enough to reach the rack power supply.

2.05 FIBER-OPTIC CABLE

- A. Exterior (Backbone from other buildings to the MDF)
 - 1. Use: Berk-Tek Type Water-Blocked/ Sunlight Resistant Indoor/Outdoor tight buffer fiber optic cables.
 - a. Indoor/Outdoor fiber-optic cables.
 - b. OFNR type where used as a riser.
 - c. Glass Type
 - d. Plenum rated cable where installed in any kind of air plenum.
 - 2. Single Mode Fiber-Optic Cable:
Berk-Tek Type Water-Blocked/Sunlight Resistant Indoor/Outdoor tight buffer fiber optic cables.
 - a. Meet Requirements of the EIA/TIA-568-A Standard Specification.
 - b. Use OFNR type where used as a riser.
 - c. Gel-filled construction.
 - d. All dielectric, 6-strand, single mode (9/125) cable with each fiber component surrounded by an individual aramid yarn strength member.
 - e. Fiber: Single mode 8.3 micron core.
 - f. Cable core mini-bundle loose tube.
 - g. Minimum Bend Radius: 128mm.
 - h. Minimum Crush Resistance: 200 N/cm.
 - i. Minimum Short-term Tensile Load: 448 lbs.
 - j. Minimum Optical Fiber Rating: 100 Kpsi.
 - k. Provide cable in full, factory packaged reels marked with the respective cable part number and lot number by the Manufacturer. Factory test reports and Contractor's acceptance tests must accompany each reel of cable.
 - l. Termination shall be with Leviton FastCAM LC Single-mode Connector (49991-SLC).
 - m. All fibers must be guaranteed.
 - 3. Multimode Fiber-Optic Cable:
Berk-Tek Type Water-Blocked/ Sunlight Resistant Indoor/Outdoor tight buffer fiber optic cables.
 - a. Meet Requirements of the EIA/TIA-568-A Standard Specification.
 - b. Use OFNR type where used as a riser.
 - c. All dielectric, 6-strand, multi-mode (62.5/125) cable with each fiber component surrounded by an individual aramid yarn strength member.
 - d. Minimum Bend Radius: 128mm.
 - e. Minimum Crush Resistance: 200 N/cm.
 - f. Minimum Short-term Tensile Load: 448 lbs.
 - g. Minimum Optical Fiber Rating: 100 Kpsi.

- h. Optical Transmission:
 - 1) Maximum Attenuation: 3.5 dB/km @ 850 nm and 1.25 dB/km @ 1300 nm.
 - 2) Minimum Bandwidth: 200 MHz/km @ 850 nm and 500 MHz/km @ 1300 nm.
 - i. Provide cable in full, factory packaged reels marked with the respective cable part number and lot number by the Manufacturer. Factory test reports and Contractor's acceptance tests must accompany each reel of cable.
 - j. Termination shall be with Leviton FastCAM LC Multimode 62.5um Connector (49991 -MLC).
 - k. All fibers must be guaranteed.
- B. Interior (Intra-Building Backbone)
- 1. Use:
 - a. Indoor fiber-optic cable.
 - b. OFNR/OFNP type where used as a riser.
 - c. Glass Type
 - d. Plenum rated cable where installed in any kind of air plenum.
 - e. Termination shall be with Leviton FastCAM LC Multimode 62.5um Connector (49991 -MLC).
 - f. Termination shall be with Leviton FastCAM LC Single-mode Connector (49991-SLC).

2.06 DATA/TELEPHONE CABLES

- A. Use:
- 1. CMP plenum rated cables in all air plenum spaces.
 - 2. Use gel-filled type cable for exterior backbone. Berk-Tek CUPIC – F 24 AWG cable.
- B. Data Cables:
- 1. Manufactured in compliance with TIA/EIA-568-A as applicable.
 - 2. Berk-Tek LanMark-6 Cable Category 6+ UTP Plenum Rated, 4-pair, UTP, 100 ohm, 23 AWG Solid cable with a Blue outer jacket.
 - 3. Provide cable in full, factory packaged reels marked with the respective cable part number and lot number by the Manufacturer.

2.07 CROSS-CONNECT TERMINATION HARDWARE

- A. Fiber Termination Patch Panels:
- 1. Minimum Size: 12 fiber optic connectors with the appropriate number of connector panels and couplers. Leviton Opt-X ULTRA Enclosures (part #'s 5R1UH-S03 and 5R2UH-S06) with loaded Adapter Plates.
 - 2. Adapter Plates (SM part #'s 5F100-4LL 24 Port or 5F100-2LL 12 Port) or (MM Aqua part #'s 5F100-4QL 24 Port or 5F100-2QL 12 Port). Fill all unused locations with Blank Adapter Plate Panels (part # 5F100-PLT).
 - 3. 19-inches rack mountable; hinged to provide complete access to connectors and slack storage from the front and equipped with cable strain relief brackets.
 - 4. Fiber termination panels shall provide ample storage and handling for up to 10 feet of slack per fiber strand.
 - 5. Fiber termination panels shall protect both the installed cable and patch cord cable interface when the panel is in the closed position.

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6. Provide LC type couplers in standard adapter plates, colors to be blue for Single-Mode, Gray for Multi-Mode quantity as appropriate to fiber count. Provide additional plates and couplers where required to terminate all fiber strands entering the rack.
 7. All single mode LC connectors shall be Leviton FastCAM, Blue in color.
 8. All multimode LC connectors shall be Leviton FastCAM, Gray in color.
 9. Fiber optic termination hardware shall be sized to accommodate required strand counts plus 20% growth.
 10. Provide blank adapter panels as required.
- B. Single Mode Fiber-Optic Cable Connectors:
1. Termination shall be with Leviton FastCAM LC Single-mode Connector (49991-SLC).
 2. Leviton FastCAM
- C. Multi-mode Fiber-Optic Cable Connectors:
1. Termination shall be with Leviton FastCAM LC Multimode 62.5um Connector (49991-MLC).
 2. Leviton FastCAM
- D. Category 6 Patch Panels:
1. Minimum Size: 24-port.
 2. Wiring Pattern: T568B.
 3. Complete with label spaces, all modular jacks shall be oriented with the locking tab slot towards the floor.
 4. Provide quantity of patch panels as required to accommodate all Category 6 UTP cables entering rack. Number of ports in panels to exceed required number of used ports by 20%.
 5. Leviton Model eXtreme TM 6+ (p/n 69586-U**) Universal Patch Panel.
- E. Patch Cables: Single-Mode Optical Fiber Duplex Patch Cords. Provide dual-fiber patch cables with LC type connectors on one end and LC connector on the other 3 meters in length for all new installations and LC type connectors on one end and LC connector on the other 3-meters in length for all new to existing installations, for each pair of single mode fiber installed. Provide 10% spare cables to Owner.
1. Category 6 patch cables: Provide one 5-foot, and one 10-foot, unshielded cable white in color, for each workstation jack, Use Leviton SlimLine Patch Cables (6D460-xx*). Provide 10% spare cables to Owner for each type of patch cable.
 2. Fiber-optic patch cables: Provide a LC 50/125 dual fiber jumper patch cable with one LC type connector on one end and LC duplex type (5LDLC-M03) second end for each multi-mode fiber in each MDF and IDF, 3-meters in length for new installations. Provide LC type connector on one end and SC duplex type (5LDCL-M03) second end for each multi-mode fiber in each MDF and IDF, 3-meters in length for new installations. Provide 10% spare cables to Owner.

2.08 PROJECT CABLE COUNTS

- A. Install six new single mode fiber cables from HH to IS Data Center
- B. Extend six existing multimode fiber cables to new IDF in HH.
- C. Extend existing multimode EMS fiber to new IDF

- D. Terminate existing Telephone wires to new IDF in HH. Maintain existing daisy chain of existing phone cables.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

All cables shall be furnished by the Contractor in full, factory packaged reels. The reels shall be marked with the respective cable part number and lot number by the Manufacturer. Upon request by the Owner, the Contractor shall provide Manufacturers proof of compliance with the required Manufacturing Guidelines presented in the aforementioned Standards. Each reel shall be visually inspected upon receipt and prior to installation to ensure that no damage was incurred during shipment. Any damaged cable shall be returned to the Vendor/Manufacturer for replacement. The cost for replacement cable shall be borne by the Contractor. Any residual cable, in lengths greater than 500 feet, shall be delivered to the Owner and the Owner shall decide the disposition of the cable.

3.02 INSTALLATION

- A. Racks/Cabinets
1. The Contractor shall be required to install, secure and ground the racks.
 2. Securely attach floor mount racks to the concrete floor using 3/8-inch hardware.
 3. Secure open racks to the overhead cable ladder using appropriate attachment hardware.
 4. Ground all racks to the telecommunications ground bus bar.
 5. Rack mount screws (#12-24) not used for installing fiber panels and other hardware shall be bagged and left with the rack upon completion of the installation.
 6. Install inter-bay and end-cap managers to the rear mounting rail of the rack using all available mounting holes.
 7. Securely fasten Interducts and cables to the cable managers.
 8. Alternate cable feeds left and right to minimize congestion at the top of the rack.
 9. Install wall mounted racks with a minimum of six 5/16-inch lag bolts or masonry anchors into structural building members.
 10. Install power outlet for cabinet within the cabinet. Do not mount outside cabinet.
- B. Backbone Cabling
1. Install a continuous, backbone cable from each outlying building to the MDF. Install a continuous, backbone cable from the MDF to each new IDF. These cables shall be of the same Manufacturer of all the other fiber and copper cabling system and terminations.
 2. Install all backbone cables in conduit.
 3. Gel-filled fiber optic cable which extends more than 50 feet within a building shall be installed in rigid conduit.
 4. Install backbone cables separately from horizontal distribution cables.
 5. Where cables are housed in conduits, install the backbone and horizontal cables in separate conduits.
 6. Where backbone cables and distribution cables are installed in a pathway system, back-bone cables shall be installed first and bundled separately from the horizontal distribution cables.

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7. All fiber optic cable shall be installed per industry standards. This includes using a proper breakaway swivel and sealing the end of all cables before pulling through any conduit system. Ten-feet of slack cable shall be left at each end of the cable run for future maintenance purposes.
 8. OSP, loose-tube cables shall be properly prepared and protected per industry standards. All cables shall be properly cleaned; the cable ends shall be terminated in a unit and a 900 micron buffer tube for each fiber strand. Each cable OSP buffer tube shall be labeled for strand counts contained therein. Where 250 micron coated cable is field terminated, provide breakout kits that build up the fiber to a minimum of 900 microns shall be used. Provide proper break out kits.
 9. Data cabling shall not occupy the same conduits as other low-voltage systems to ensure the data network can be upgraded and expanded in the future without disturbing the other critical communications systems.
- C. Horizontal Distribution Cabling
1. Install horizontal distribution cables from the MDF and IDF to all workstation data outlets as indicated on Plans. Install one continuous horizontal cable from each data jack back to the associated MDF or IDF. If a data outlet has more than one jack, install one cable for each jack. Unless indicated otherwise on Drawings, install a minimum of three cables (CAT 6+) for each outlet indicated on the Plans. Provide additional cables where specifically indicated on the Plans.
 2. Install all cable in conduit in in-accessible space.
 3. Install cable in accordance with Manufacturer's recommendations and best industry practices.
 4. Do not fill cable raceways greater than the NEC maximum fill for the particular raceway type.
 5. Conduit sizing:
 - a. Minimum of 1 inch conduit for each outlet. Each outlet shall be fed by a single home run conduit. "Daisy Chaining" of outlets is not acceptable.
 - b. For conduits feeding a multiple outlet surface raceway the sizing shall be as follows:
 - 1) 1-inch for raceways 6-feet long and under.
 - 2) 1½-inch for raceways 6-feet to 18-feet long.
 - 3) Multiple conduits to meet this pattern for lengths greater than 18-feet.
 - c. These Specifications shall take precedence over conduit routing shown on the Plans that deviate from this method. The data Contractor shall bring any discrepancies to the attention of the Owner before bid time.
 6. Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document.
 7. Where cable splices are allowed, they shall be in accessible locations and housed in an enclosure intended and suitable for the purpose.
 8. Do not exceed the cable's minimum bend radius and maximum pulling tension.
 9. Cable Not Installed In Conduit:
 - a. Cable may be installed exposed (not in conduit) only in readily accessible areas and only where indicated on the Plans or in this Specification.
 - b. When not installed in conduit, (per the Plans and Electrical Specifications Requirements), support all horizontal cables at a maximum of 4-foot intervals.
 - c. At no point shall cable(s) rest on acoustic ceiling grids or panels, nor shall they be attached to ceiling grid wires.

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- d. Horizontal distribution cables shall be bundled in groups not greater than 40 cables. Bundles shall be supported by cable tray, conduit, trapezes, or multiple support straps.
- e. Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- f. Under no circumstances shall cable be installed exposed (not in conduit) above enclosed (hard lid) ceilings, the use of access doors is not acceptable.
- g. Cables shall not be attached to ceiling grid or lighting support wires. Where light support style wires for drop cable legs are required, the Contractor shall install clips to support the cabling.
- 10. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- 11. Cables shall be identified by a self-adhesive label in accordance with TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a Section of cable that can be accessed by removing the cover plate.
- 12. Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables Outside Diameter (4 X cable O.D.) at any point in the run and at the termination field.
- 13. Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle.
- 14. A minimum 6 inches of slack shall be left in the outlet box to allow at least one re-termination.
- 15. All cables and their termination on each end shall be labeled per TIA/EIA. All labeling schemes and label designations shall be reflected on the CAD Drawings at the end of the Project and in the submittals. A bound copy of the cable designations showing the termination point by floor, room number and where in the room each patch panel jack is assigned shall be attached to the rack in each MDF and IDF.
- 16. **Cable Terminations**
 - a. Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA Document, Manufacturer's recommendations and/or best industry practices.
 - b. Pair untwist at the termination shall be per Manufacturers recommendation.
 - c. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
 - d. The cable jacket shall be maintained as close as possible to the termination point.
 - e. All modular jacks shall be oriented with the locking tab slot towards the floor.
 - f. Data jacks that are in surface raceway shall be mounted in the proper termination plate by the Manufacturer of the raceway to ensure that the customer gets a professional end product. These termination plates and trim are to be provided by the Electrical Contractor installing the raceway and power outlets to ensure that all outlets and trim will match.
 - g. Each jack shall be fed by a separate four pair cable sheath. All four pairs shall be wired to the jack using TIA/EIA-568-B wiring scheme.

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17. Data cabling shall not occupy the same conduits as other low-voltage systems to ensure the data network can be up-graded and expanded in the future without disturbing the other critical communications systems.

D. Inter-Building Multi-Pair Copper Backbone for Voice Terminations

1. In the MDF, install 110 Wall Mounted Frames on Backboard adjacent to the PBX
 - a. Use Leviton Velcro (43115-075*) to support both Backbone and Horizontal Cabling.
 - b. Provide Leviton 110 Extension Mounting-Frame Kit (41MB2-EXT) adjacent to the PBX Wall Field and appropriate 110 Horizontal and Vertical Management.
 - c. Use waterfall type cable management to provide strain relief for both Backbone and Horizontal Cabling transitioning from the Wall Field to Racks.
 - d. Do not over tighten cabling bundles.
 - e. All cabling to be neatly dressed and secured with Velcro Straps.
 - f. All cabling and terminations shall be tested to applicable Standards.
 - g. Install and provide all necessary components, accessories and system management to secure all communications infrastructure.
 - h. Provide proposed Cabling Plan prior to construction to Citrus College Project Manager for approvals.

E. Data Outlets

1. This Section only applies to outlets not installed in surface raceway.
2. The outlet plate shall be affixed to an in-wall or surface mount box with two screws, which match the color of the outlet plate.
3. Wall mount boxes shall be attached to box eliminators, 4-inches X 4-inches boxes, or old work boxes.
4. Install faceplates in a horizontal or vertical orientation as required.
5. Any unused faceplate positions shall be covered/filled with a blank insert made of the same or compatible material as the faceplate and shall be molded in the same color. Blank spaces shall be incorporated between populated positions on the faceplate.
6. Cables shall be coiled in the in-wall or surface-mount boxes. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. A minimum of 6 inches of slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack for these situations shall be neatly coiled in the ceiling above the drop location.

F. Cross-connect Termination Hardware

1. The backbone side of the horizontal cross-connect, and the main cross connect shall be terminated in the same termination panels as the horizontal cables. The backbone fibers shall be maintained in separate termination panels from the horizontal distribution fiber cables. The backbone termination panels shall be installed in the rack. Termination details and rack elevations for fiber panel placement shall be provided in the Contractor submittals.
2. The Contractor shall only be required to install those fiber termination panels provided by the Contractor into the enclosures. Placement of the enclosures shall be detailed in the Contractors Working Drawings.
3. Each fiber optic cable shall be terminated in the MDF and IDF in an LEVITON enclosure providing protection to the terminated fibers. The enclosures shall provide a strain relief bracket for attaching the optical fiber cable and support

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- slack storage of a minimum of 10 feet per fiber cable. The enclosure shall provide a minimum of 12-ports for fiber terminations and fully enclose both the hardwired cable and the patch cord terminations when the shelf is closed.
4. Fiber termination panels must be of the same Manufacturer as the fiber cable and LC connectors, as well as the horizontal cabling system to ensure the Owner will not have any Coordination problems in the future.
- G. Labeling and Identification
1. All cables and their termination on each end shall be labeled per TIA/EIA. All labeling schemes and label designations shall be reflected on the CAD Drawings at the end of the Project and in the submittals. A bound copy of the cable designations showing the termination point by floor, room number and where in the room each patch panel jack is assigned shall be attached to the rack in each MDF and IDF.
 2. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the As-built Drawings and all test documents shall reflect the appropriate labeling scheme.
 3. All label printing will be machine generated using indelible ink ribbons or cartridges. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet labels will be the Manufacturer's label provided with the outlet assembly.
 4. Labeling at the workstation end will consist of destination of cable, rack number, patch panel number, port number. I.E. MDF-1-1-45.
- H. Grounding and Bonding
1. The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential for acting as a current carrying conductor. The TBB shall be installed independent of the buildings electrical and building ground and shall be designed in accordance with the recommendations contained in the TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
 2. The main entrance facility/equipment room in each building shall be equipped with a Telecommunications Main Grounding Bus bar (TMGB). Each telecommunications closet shall be provided with a Telecommunications Ground Bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
 3. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TC or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors. Where metallic panels attached to the rack do not have sufficient metal to metal contact to provide an adequate path to ground, they shall be bonded to the rack using a minimum #14 AWG copper conductor. The copper conductor size shall be upgraded based on the largest power conductor feeding any rack mount

- equipment. The conductor shall be continuous; attaching all isolated components in a daisy chain fashion from top to bottom and bonded to the rack using the appropriate compression connector.
4. The Electrical Contractor shall provide a #6 building ground wire to each data rack from the corresponding building grounding electrode system. This ground will be connected to the MDF or IDF grounding bus for the grounding of all the telecommunications equipment.
 5. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and buss-bars shall be identified and labeled in accordance with the System Documentation Section of this Specification.
 6. The TBB shall be designed and/or approved by a qualified PE, licensed (actual or reciprocal) in the State that the work is to be performed. The TBB shall adhere to the recommendations of the TIA/EIA-607 Standard and shall be installed in accordance with best industry practices. Installation and termination of the main bonding conductor to the building service entrance ground, at a minimum, shall be performed by a licensed C10 Electrical Contractor.
- I. **Firestop Systems**
1. A firestop system is comprised of: the item or items penetrating the fire rated structure; the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and pressurized water stream.
 2. All penetrations through fire rated building structures (walls and floors) shall be sealed with an appropriate firestop system. This Requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating items i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
 3. Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a Qualified Professional Engineer (PE), Licensed (actual or reciprocal) in the State where the work is to be performed. A Drawing showing the proposed firestopped system, stamped/embossed by the Cognizant PE shall be provided to the Owner's Technical Representative prior to installing the firestop system.
 4. All firestop systems shall be installed in accordance with the Manufacturer's recommendations and shall be completely installed and available for inspection by the District Inspector prior to cable system acceptance.

3.03 TESTING

- A. All cables and termination hardware shall be 100% tested for defects in installation to verify cable performance under installed conditions. All conductors of each installed cable shall be verified useable by the Contractor prior to system acceptance. Any defect in the cable system installation including but not limited to cable, connectors, feed-through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

- B. Category 6 cables shall be certified to meet or exceed the Category 6 Specifications set forth in TIA/EIA-568-C Certifications shall include the following parameters for each pair of cable installed:
1. Wire map (pin to pin connectivity)
 2. Length (in feet)
 3. Attenuation
 4. Near End Crosstalk (NEXT)
 5. Far End Crosstalk (FEXT)
 6. ELFEXT
 7. Attenuation/Crosstalk Ratio (ACR)
 8. Return Loss
 9. Propagation Delay
 10. Delay Skew
- C. Fiber Optic Cables shall be certified to 10GBs minimum.
- D. Copper
1. Each cable shall be tested for continuity on all pairs and/or conductors. Coaxial cables shall be tested for continuity, opens shorts and resistance using a Volt/Ohm Meter (VOM) and installed length using a Time Domain Reflectometer (TDR). Twisted-pair voice cables shall be tested for continuity, pair reversals, shorts, and opens using a “green light” type test set. Twisted-pair data cables shall be tested for the all of the Above Requirements, plus tests that indicate installed cable performance. All Category 6 cables shall be tested to ensure the Category 6 standard performance is complied with. All tests shall be printed out in hard copy in the quantity called out in the General Specifications for O&M turn over documents as well as one disc copy for the Owners use. These data cables shall be tested using a (Class VI) cable analyzer.
 2. Continuity
 - a. Each pair of each installed cable shall be tested using a “green light” test set that shows opens, shorts, polarity and pair-reversals. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test set in accordance with the Manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
 3. Length
 - a. Each installed cable shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the TIA/EIA-568-A Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the longest pair length shall be recorded as the length for the cable.
 4. Performance Verification
 - a. High speed Unshielded Twisted Pair (UTP) data cable shall be performance verified using an automated test set. This test set shall be capable of testing for the continuity and length parameters defined above, and provide results for the following tests:
 - 1) Near End Cross-Talk (NEXT)

- 2) Attenuation
- 3) Ambient Noise
- 4) Attenuation to Cross-Talk Ratio (ACR)
- 5) Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA/EIA Standard, and the result shown as pass/ fail. Test results shall be printed directly from the test unit or from a download file using an application from the Test Equipment Manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved.

E. Fiber

1. All fiber terminations shall be visually inspected with a minimum 200 X microscope to ensure that no surface imperfections exist. In addition, each fiber strand shall be tested for attenuation with an optical power meter and light source. Cable length and splice attenuation shall be verified using an OTDR.
2. Attenuation
 - a. Single mode optical fiber attenuation shall be measured at 1310 nm and 1500 nm using a laser light source and power meter. Tests shall be performed at both wave-lengths in one direction on each strand of fiber. The set-up and test shall be per-formed in accordance with EIA/TIA-526-7 Standard, Method 1A. Two meter patch cords shall be used as test references and for the actual test. This test method utilizes a one jumper reference, two jumper tests to estimate the actual link loss of the install cable plus two patch cords.
 - b. Test evaluation for the panel to panel (backbone) shall be based on the values set forth in the EIA/TIA-568-C, Optical Fiber Link Performance Testing.
 - c. *For this application, the length based on cable length measurements marked on the jacket, will be suitable. OTDR testing is to be performed in accordance with 8.2.2, and then the actual measured length shall be used. Conversion from metric to US Standard measurement shall use 3.2808 as a constant with the result rounded to the next highest whole number.
 - d. **The testing for this Project is measuring the loss over the installed cable plus two jumpers which accounts for three mated pairs of connectors. Subtract one mated pair for the equipment interface to arrive at a total of two mated pairs under test.
3. Length and Splice Loss
 - a. Each cable shall be tested with an Optical Time Domain Reflectometer (OTDR) to verify installed cable length and splice losses. The OTDR measurements for length shall be performed in accordance with EIA/TIA-455-60. The measurements to determine splice loss shall be performed in accordance with Manufacturer's recommendations and best industry practices. These tests shall be employed on all cables after installation and in addition where one or more of the following conditions exist.
 - b. OTDR and power meter testing is specifically requested by the Owner.
 - c. Each strand shall be tested on all outside plant and tight-buffered cables and/or where splices exist.
 - d. A Representative strand of each fiber cable shall be tested to verify length if the estimated cable length is within 10% of the maximum length specified, respective to cable function, in the TIA/EIA-568-C Standards.

3.04 CABLE SYSTEM ACCEPTANCE

- A. The Owner's Technical Representative will make periodic reviews of the Project in progress. One review will be performed at the conclusion of cable pulling, prior to closing of the false ceiling, to verify the method of cable routing and support, and the firestopping of penetrations. A second review will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with TIA/EIA Specifications for jacket removal and pair untwist, compliance with Manufacturer's minimum bend radius, and that cable ends are dressed neatly and orderly.
- B. Final Review
- C. Upon completion of the Project, the Owner's Technical Representative will perform a final review of the installed cable system with the Contractor's Project Foreman. The final review will be performed to verify that all horizontal and backbone cables were installed as defined in the Drawing package, and that the installation meets the aesthetic expectations of the Owner.

3.05 TEST VERIFICATION

Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a Representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment. If significant discrepancies are found the Contractor will be notified for resolution.

3.06 SYSTEM PERFORMANCE

During the 4-week period between final inspection and delivery of the Test and As-Built Documentation, the Owner will activate the cabling system. The Owner will verify operation of the cabling system during this period.

END OF SECTION 26 6010
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