Rancho Santiago Community College District
Santa Ana College Science Center

1530 W. 17th St., Santa Ana, CA

Specifications

DSA APPROVAL SET
Volume Three
Divisions 26 - 33

Architecture | Engineering | Planning

Hammel, Green and Abrahamson, Inc.
Architects and Engineers
1918 Main St., Third Floor
Santa Monica, California 90405
(310) 557-7600

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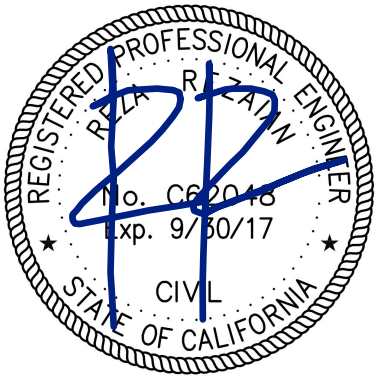

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SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 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 Sub-Contractors or in establishing the extent of work to be performed by any trade.

1.2 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.

1.3 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.

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 3-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.

1.4 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.

1.5 PERMITS

Take out and pay for all Required Permits, Inspections and Examinations without additional cost to the District.

1.6 QUALITY ASSURANCE

A. Work and Materials shall be in full accordance with the latest Rules and Regulations as follows. The following 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.)
    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.

1.7 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.
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: 5/12/98 Submittal #4 Contents: Branch circuit panelboards Sheet #E5.1 and transformers Specification Section 26 0505 Paragraph 2.11, etc.).*
    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: 10/9/98 Original Submittal #4 resubmittal Revision R2 Contents: Transformer resubmittal Specification Section – 26 0505 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 durations 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.

1.8 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.

1.9 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 AASHO-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 ¼-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 ampere 120 volt duplex receptacles; shall indicate circuit voltage, ampere, phase and source circuit number.
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 ½-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 Armtek 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 pull boxes 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.
   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.
   4. Test equipment shall be accurate within plus or minus 1%.
   5. Branch circuit devices 40 ampere 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 COMMISSIONING - CX

A. General

1. The Commissioning shall verify the electrical systems for the term of the Contract, by observation; and by calibration; and by testing. The Commissioning shall ensure the electrical systems perform interactively and correctly, according to the Contract and Operational Requirements.
2. Commissioning shall provide startup, testing and documented confirmation of the Contract Constructed Systems, materials and work, functions in compliance within the criteria set forth in the Contract Documents to the satisfaction of the District's needs. The Commissioning Scope shall encompass each system identified as requiring "Commissioning" by the Contract Documents, including but not limited to:
   a. Electrical circuits' protection, short circuit, overcurrent, and ground fault devices.
   b. Electrical circuits monitoring and metering.
   c. Light fixtures, lamps and ballasts.
   d. Lighting control devices, equipment and lighting control systems.
   e. Standby and emergency electric power supply equipment and systems.
   f. Fire alarm, equipment, devices and fire alarm systems.
   g. Additional systems described in the Contract Documents.
3. Commissioning process shall review all of the Shop Drawing submittals, including:
   a. Controls, Operation and Maintenance requirements.
   b. Facility performance testing compliance.
   c. Project Contract requirements compliance.
   d. Compliance with basis for design and operational descriptions provided in the Contract.
4. Commissioning shall be the process of ensuring all the systems described in the Contract Documents comply with the Contract Document design; all systems are installed properly; all systems are functional, tested and capable of being operated and maintained to perform within the Contract requirements and design intent.
5. Functional setup, recalibration, correcting deficiencies, retesting and the associated costs, for system(s) that fail Commissioning, shall be the responsibility of the Contractor. The Contractor shall include all Commissioning costs in the Contract Scope of Work.
6. Complete all Commissioning functions prior to the occupancy of the facility by the District, unless directed otherwise by the District's Representative.
7. Submit six copies of Commissioning Documentation to District's Representative.
8. Commissioning, unless specifically indicated otherwise, shall be performed by Factory-Trained Technician(s) Authorized and Certified by the Manufacturers of the respective equipment/ systems. Where specifically indicated, Commissioning shall be performed by Independent Test Lab.

B. Commissioning Procedures

1. Prepare a Commissioning matrix identifying components and systems included in the Commissioning Scope; the status; actions completed and actions to be completed.
2. Verify Contractor compliance with Contract Document requirements Manufacturer's recommendations and approved Shop Drawings.
3. Perform startup, functional tests, reports, and document results.
4. Evaluate and document the setup parameters, software, operating condition and performance of each system at the time of functional test completion. Document and record each performance parameter and condition, in the Commissioning Report.
5. Schedule testing and prepare descriptions of testing.
6. Describe measures performed to correct deficiencies.
7. Verify that instructions to District's Representatives, Operations and maintenance manuals comply with Contract Documents.
8. Prepare warranty matrix identifying the start dates, expiration dates, routine preventative maintenance dates and the District's responsibility for performing preventative maintenance and keeping logs for each maintenance function and warranty claims.

9. Confirm completion of all punch list items that have been acceptably accomplished and a list of what has not been acceptably completed.
10. Describe uncorrected deficiencies accepted by the District.

C. Commissioning Phasing

The Commissioning Phases of work shall include the following activities:

1. SDQ – Shop Drawing Qualification shall verify complete and correct Shop Drawings have been submitted.
2. IQ – The Installation Qualification of Contract Work shall verify systems are correctly and properly installed.
3. OQ – Verify systems interfaces and software are correctly and properly operational.
4. ITM – Verify the Contract Inspection, Testing and procedures for Maintenance are complete.
5. PQ – Performance Qualification complete the functional performance testing to validate each building system.

1.14 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:

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.

1.15 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.

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.

1.16 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.

1.17 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 Study.
   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.

1.18 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.

1.19 SPARE FUSES

Provide three spare fuses for each size and type at each location to match the installed fuses where the fuses are provided as part of the Contract. Provide spare fuse holders on inside door of each respective fuse compartment. Provide engraved nameplate on front of fuse access door indicating fuse type/catalog number ampere rating and Manufacturer of fuse.

1.20 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.
   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. Areo-dynamic 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.

1.21 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 inter-connection circuits, electrical equipment, panels, and circuit protection devices, nominal 50% (½-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 260500
022316/1010006

SECTION 260505
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 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.
3. See General Commissioning Requirements, Section 019113.

1.2 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

2.1 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 quantities 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 outlet boxes of proper code size for the number of wiring devices, connecting conduits, and conductors/cables or conduits passing through or terminating therein. In no case shall outlet 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.
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 "Homerun" or Conduit "Homerun" connects to outlet box.
4. Signal, Communication and Low Voltage Outlet Boxes:
   a. Individual or duplex audio/visual, telephone, computer or data outlets: 4.69-inches square by 2.125-inches deep minimum with single gang wide extension ring.

b. Combination AV/signal/telephone/data or computer outlets: 4.69-inches square by 2.125-inches deep minimum with 2-gang wide extension ring.

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 square by 2.5-inches deep, but not less than size indicated on the Drawings or required by Code.
6. Provide extension rings on flush outlet boxes and flush junction boxes, to finish face of extension ring flush to (within ± 0.63-inches) of finished building surfaces. Extension ring shall match outlet box materials/construction and contain "attachment mounting-tabs" for wiring devices. Extension rings shall be "screw-attached" to respective 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.
      3) Not in contact with concrete or masonry.
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, between and separating each device.
    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, supplemental 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 outlet box with corrosion resistant gasketed water tight, hinged, key locking cast metal, self-closing cover. Tamper resistant and vandal resistant.
    b. UL-listed and labeled for installation in masonry, cast-in-place concrete, hollow-framed walls and wet locations.
    c. Flush cast-iron or cast-bronze or brass, device back-box, nominal 4.68-inch square by 2.25-inch deep.
    d. Internal metal adapter plate for wiring device types, in the box as indicated on the Drawings.
    e. As manufactured by Legrand/Pass and Seymour #4600 Series; or C.W. Cole #310 Series.
14. PVC Coating
    a. Metal outlet and junction boxes installed in outdoor or exposed non-weather protected locations shall be PVC coated.
    b. PVC coating shall be factory applied, to comply with NEMA-RN1 and 5-19.
    c. The adhesion of the PVC coating to the metal box 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) Box exterior surfaces, 40-millimeter coating thickness.
   2) Box interior surfaces, 10-millimeter coating thickness.

15. 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.

C. Floor Boxes

1. General:
   a. 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 floor tiles, carpeting and exposed wood and concrete floor fishes.
   b. Electrical power receptacles in a floor box; shall be industrial grade wet location heavy-duty, high-abuse rated devices, tamper resistant. Grounding type, 125 volts, 60Hz AC, 20-amperes, NEMA 5-20R (duplex), or other NEMA configurations noted on the Drawings. Standard length receptacle mounting strap as required by the Manufacturer of floor box being furnished.
   c. Tested, listed and labeled to comply with UL-514A and/or UL514C.
2. Concrete floor outlet box for chair/seat aisle light fixture connection:
   a. Flush-in -concrete floor box, brass or cast iron, nominal 18-cubic inches internal wire capacity, removable screw attached flush top cover.
   b. Minimum of three 0.75-inch conduit threaded entrances; one surface/top entrance location for aisle light fixture connection to box, plus two side and bottom locations for “in-out” branch circuit connections.
   c. The top entrance conduit position shall not interfere with removal and reinstallation of the box top cover, with the top conduit connected between the box and aisle light fixture and the top of the box set flush with finish floor surface.
   d. Box and conduit shall be protected and concealed, below each respective aisle seat containing an electric aisle light fixture. Orientation of top entrance conduit to match position of aisle light fixture.
   e. As manufactured by Hubbell #F3185 Series; no known equal.
3. Poke-Thru floor boxes for “After-Set” Floor Outlets.
   a. Through floor wiring for power and communication shall be UL listed with a fire and temperature rating of not less than 2-hours. The units shall include an internally divided floor fitting; a divided through-floor conduit/raceway, and a divided under floor junction “split-box” not less than 4.7-inches by 4.7-inches by 2.125-inches in size. Junction box shall be installed concealed in ceiling space of the floor below. The length of the floor “through-raceway” shall match the thickness of the finish floor and as recommended by the Manufacturer. Unit shall be self-supporting without the attachment of an above floor fitting. Internal isolation barriers between high potential and low potential circuits and sections. The integral fire barrier shall incorporate a cold smoke barrier to prevent the passage of smoke when heat is not present.
   b. Poke-Thru Floor boxes shall contain dual services for high potential and low potential devices and circuits.
   c. Poke-Thru Floor pedestal type; (internally divided high potential and low potential sections) service fittings die cast, brushed aluminum, single piece device housing, with stainless steel device cover plates front and rear of the housing as follows:
      1) Front side (high potential) one 20-ampere, 120 volt, 60Hz, AC, grounding duplex convenience outlet plugs.

2) Rear side (low potential) shall contain “knockouts” or “keystones” as follows at locations shown on the Drawings:
   a) Knockouts for signal cables one 1-inch diameter and two ⅜-inch diameter with rubber bushing grommets for each knockout.
   b) Four RJ-45 keystone, snap-in retainers for low potential plug-in signal connections.
   c) The Contractor shall provide the type of outlet(s) at each poke-thru location as required by the Low Voltage-Signal Contract Documents.
3) Alternately where specifically indicated on the Drawings, the front and rear cover plates shall be supplied with knockouts for 1.0-inch flexible conduit “Furniture” connection, one per cover plate.
4) The pedestal shall provide 0.25-inch or greater protective over-hang (drip-lip) of the device coverplates. Provide stainless steel device coverplates.

d. Non-Pedestal Poke-Thru flush in floor type; (internal divided high potential and low potential sections) die cast, flush with finish floor, metal cover flip-open, locking, hinged access covers. Open-close die cast aluminum port-covers for plug-in portable cable connections. ADA compliant, wide trim matching flange.
   1) Two 20-ampere, 120 volt, 60Hz, AC, grounding duplex convenience receptacles for high potential power connections.
   2) Four RJ-45 keystone, snap-in retainers for low potential plug-in signal connections. The Contractor shall provide the type of outlet(s) at each poke-thru location as required by the Low Voltage-Signal Contract Documents.
   3) Cover shall close and lock after portable plug-in cables have been inserted into respective connections, under the cover.
   4) UL wet mop, scrub water rated for carpeted and non-carpeted floors.
e. Die cast aluminum cover, nominal 8-inch diameter metal housing flush in “core-hole”, outlet metal body size.
f. Flush with floor or pedestal type as indicated on Drawings. As manufactured by Wiremold/ Legrand# Evolution Poke-Thru 8AT Series, Smoke and Fire Rated Poke-Through fittings; no known equal.

4. Floor Boxes for Flush Floor Outlets (non-pedestal), recessed concealed inside outlet box, plug-in receptacles.
   a. Provide cast-in-floor with concrete pour pan, rated for on grade to prevent direct earth contact, cast-in-place concrete floors on-grade and above-grade; adjustable "leveling-feet" for box.
   b. UL wet mop, scrub water rated for carpeted and non-carpeted floors. UL-File E171211 installation fire rating and/or UL-Fire Resistance Classified.
   c. Floor boxes shall contain dual services:
      1) High potential with not less than two 120 volt 60Hz AC 20-ampere grounding duplex convenience receptacles.
      2) Low potential for low voltage system outlets and signal circuits with up to and including eight RJ-45 plug-in keystone snap-in retainer receptacles. The Contractor shall provide the type of outlet(s) at each poke-thru location as required by the low voltage-signal Contract Documents.
      3) Internal isolating barrier between high and low potential circuits and sections of box.
      4) Also refer to Drawings for additional outlet requirements.
   d. Conduit knockouts in bottom of box and in each side walls of box. Not less than one 1.25-inch and one 0.75-inch knockouts for both low potential and high potential conduits connections on each opposing box sides. Include the same configuration of knockouts on the bottom of the box, for high potential section and low potential sections.
   e. Floor box cover:
      1) Flush tamper resistant "lock-down” removable main cover. Independent hinged "flip-out" port in the removable cover, to allow main box cover to be in a fully closed position with "plug-in" cords connected into box when the lock-down cover is closed. Main cover "lock-down" to prevent non-authorized access into box interior.
      2) Brass, removable recessed main cover, rated for carpet, or tile for floor finish, brass overlapping trim cover finish. Cover recess depth 0.25-inch, 0.5-inch or 0.75-inch as required to match respective floor covering thickness and type. ADA compliant, wide trim matching flange.

f. Floor box with metal body, nominal box size 10-inches by 12-inches by depth to match floor, but not less than 3.0-inches deep box.
g. Floor box as manufactured by FSR #FL-500P Series; no known equal.

2.2 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 attached 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 weathertight cover of same material.

C. Concrete Pull Boxes and Hand-Holes for Electrical
1. AASHTO H-20 traffic loading 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 cable support blocks.
2. Boxes shall be “Intercept” type with Multiple Box Sections. 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-Sping” assist, hinged open-close.
4. Box covers shall comply with Federal ADA, UL, State and Local AHJ for slip resistance. Provide cast-or-bead weld on cover of 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.).
5. Shall be set on a machine-compacted pea gravel base 12-inches thick with gravel base extend 6-inches beyond box base on all sides. Provide a 0.75-inch by 10-feet copper clad ground rod through the box bottom with 9-inch projection into box, for grounding all metal parts and frames with continuous #10 AWG copper bond wire.
6. Seal all box joints and seal box between cover and frame with a mastic compound similar to Parmagum or Dukseal. After cables have been pulled, connected, tested and inspected, seal box cover and bolt-close cover.
7. As manufactured by Jensen Precast; or Oldcastle Precast.

2.3 SWITCHES, WIRING DEVICES

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 ampere; unless indicated otherwise on Drawings.
3. Color as selected by Owner’s Representative. Switches and wiring devices 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 wet-location 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

Manufacturer	Toggle Type	Lock Type
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

Manufacturer	Toggle Type	Lock Type
Hubbell	#HBL1222	#HBL1222-L
Legrand/P&S	#20AC2	#20AC2-L
Leviton	#1222	#1222-L
Cooper-Arrow/Hart	#AH1222	#AH1222-L

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

Manufacturer	Toggle Type	Lock Type
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

Manufacturer	Toggle Type	Lock Type
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

Manufacturer	3-Position Regular	3-Position Lock
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

	Toggle Type		Lock Type	
Manufacturer	1-Pole	2-Pole	1-Pole	2-Pole
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. Switches – Shall be Decorator ("Rocker" type operations) Style, for residential locations only.

1. 120 volt 60Hz AC, rated 15 ampere for lighting loads and rated 20 ampere for non-lighting loads, unless indicated otherwise on Drawings.
2. Single Pole Switches

Manufacturer	Rocker Type
Legrand/P&S	#TM870
Hubbell	#RSD115

Leviton	#5621-2
Cooper-Arrow/Hart	#7501

3. Double Pole Switch

Manufacturer	Rocker Type
Legrand/P&S	
Hubbell	#RSD215
Leviton	#5622-2
Cooper-Arrow/Hart	#7502(extra)

4. Three-Way Switches

Manufacturer	Rocker Type
Legrand/P&S	#TM873
Hubbell	#RSD315
Leviton	#5623-2
Cooper-Arrow/Hart	#7503

5. Four-Way Switches

Manufacturer	Rocker Type
Legrand/P&S	#TM874
Hubbell	#RSD415
Leviton	#5624-2
Cooper-Arrow/Hart	#7504

6. Momentary Contact Switches

Manufacturer	3-Position Regular
Legrand/P&S	#TM870(extra)
Hubbell	#RSD(extra)
Leviton	#5624-2
Cooper-Arrow/Hart	#7521

7. Maintained Contact Switches (Double Throw, Center Off).

	Rocker Type	
Manufacturer	1-Pole	2-Pole
Leviton	#5685-2	#5686-2

8. Pilot lights used in conjunction with circuit switches shall be LED type with red jewel.

D. 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.

E. 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.

2.4 ELECTRIC RECEPTACLE WIRING DEVICES

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.
   2. All receptacles shall be a product of the same Manufacturer.
   3. Receptacle color as selected by OWNER'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, provide tamper resistant receptacles in buildings containing: dormitories, guestrooms, condominiums, housing/residences, apartments, dwellings, hotels/motels, classrooms, secondary schools K through 12th grade, child-care/day-care/kindergarten, hospital pediatric-care units and other locations required by AHJ.
    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-ampere and 20-ampere 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-ampere branch circuits with a single duplex convenience receptacle connection on each circuit, receptacles shall be rated for 20-ampere.
    c. 15-ampere and 20-ampere branch circuits with two or more duplex convenience receptacle connections each circuit, receptacle shall be rated 15-ampere or 20-ampere.
7. Devices shall additionally be listed and labeled as UL-All Weather-Resistant, provide weather resistant receptacles for the following install locations. Modify Manufacturer’s catalog number descriptions, shall include all-weather-resistant UL listing and labeling:
    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. Refer to “Floor Boxes” for additional receptacle requirements”.
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.).
10. “Split-wire” duplex convenience receptacles. Each split-wire receptacle plug connects on independent common circuit. Provide nameplate or graphic on face of receptacle describing the receptacle function and control source. Comply with California Title-24 and ASHRAE-90.1, latest revisions.

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. Duplex, rated 120 volt 60Hz AC, 20 ampere, unless indicated otherwise on Drawings.
3. Heavy Duty Industrial Grade

Manufacturer	NEMA 5-15R	NEMA 5-20R	NEMA 5-20R-GFCI
Legrand/P&S	#5262	#5362	#2095HG
Leviton	#5262.	#5362	#W7899
Hubbell	#CR5252.	#5362	#GFR8300
Cooper-Arrow/Hart	#AH5262.	#AH5362	#WRVGF20

C. Isolated Ground Receptacles-IGR
1. The receptacle insulation barrier shall isolate the receptacle ground contact system from ground. Connect the ground plug contact to a separate dedicated insulated ground-bonding conductor. The receptacle ground plug contact shall not be grounded to the raceway or outlet

box. Isolated ground duplex convenience receptacle 20-ampere minimum, with two current carrying contacts and one grounding contact, or as noted on the Drawings.

2. High-abuse, heavy-duty industrial grade, NEMA 5-20R, duplex convenience receptacles.
3. Identify receptacle with an orange triangle on the receptacle face and orange receptacle body. Red body for receptacles connected to emergency power.

Manufacturer	NEMA 5-20R
Legrand/P&S	...#IG6300
Leviton	.…#5362IG
Hubbell	.…#CR5352IG
Cooper-Arrow/Hart	.#IG5362

D. Hospital Grade Duplex Convenience Receptacles

1. Receptacles shall be Underwriters Laboratories listed hospital high abuse, heavy-duty rated grade.
2. Duplex convenience receptacles shall be grounding type 120 volt with two current carrying contacts and one grounding contact which is internally connected to the frame. Outlets shall accommodate standard parallel blade cap and is side wired.
3. Ground Fault Circuit Interrupter (GFCI or GFI) 20-ampere duplex convenience receptacles with test-reset buttons and visual pilot. Shall be all Weather-Resistant and wet location rated.

Manufacturer	NEMA5-15R	NEMA5-20R	NEMA5-20R-GFCI
Legrand/P&S	#8200HG .	#8300HG	#2095HG
Leviton	#8200HG .	#8300HG	#HG-7899
Hubbell	#8200 . .	#8300	#GFR8300
Cooper-Arrow/Hart .	#AH8200 .	#AH8300	#TRVGFH20

E. Weather Proof (W.P.) Receptacle

1. Outdoor receptacles shall be duplex convenience GFCI type rated 20-ampere 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.

F. Duplex convenience receptacles, for residential locations only.

1. Receptacles shall be “Decorator” type, grounding type, 120 volt, 60Hz AC, and shall have two current carrying contacts and one grounding contact which are internally connected to the frame.
2. Outlet shall accommodate standard parallel blade cap and shall be side wired.
3. GFCI receptacles shall provide test-reset buttons and visual pilot. Rated 120 volt 60Hz AC, unless indicated otherwise on Drawings. GFCI receptacles shall be wet location and all Weather-Resistant rated.
4. Tamper Resistant Receptacles
   a. All the electrical receptacles shall be rated “Tamper Resistant Receptacles” for 120 volt, 15-amp and 20-amp (TR), UL-TR (RTRT). Spring-loaded shutters shall automatically open-close (unblock-block) the receptacles slots, when the plug-in (cap) insertion and removal occurs.

Manufacturer	NEMA 5-15R	NEMA 5-20R	NEMA 5-20R-GFCI
Legrand/P&S	#885TR	#TR26362	#2095TRWRW
Leviton	#T5325	#T5825	#W7899TR
Hubbell	#RRD15STR.	#RRD20STR	#GFTR20
Cooper-Arrow/Hart	#TR1107	#TR6350	#TWRVG20

G. 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.

2.5 PLATES

A. Metal Cover Plates for Devices
   1. Provide cover plates for every line voltage and low voltage switch, receptacle, telephone, computer, television, signal and other device outlets.
      a. All line voltage circuit plates shall be metal, 0.040-inch stainless steel Type 302 alloy, composed of 18% chromium and 8% nickel.
      b. Plates for low voltage signal systems may be metal or non-metal. Non-metal plates shall be high-abuse, hard-service and high-impact resistant.
   2. Plates shall be as manufactured by P&S; or Hubbell; or Leviton; or General Electric.

B. Residential Location Project non-metal cover plates for line voltage and low voltage devices.
   1. Provide plates for every line voltage and low voltage switch, receptacle, telephone, computer, television, signal and other device outlets. Non-metal, heavy-duty, high-abuse and high-impact resistant plates.
   2. Plates shall be same Manufacturer as the respective wiring device.

2.6 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, communications equipment, fire alarm, blank covers, wall and ceiling plates to be spanner head stainless steel, tamperproof type. Provide OWNER with six screwdrivers for this type.

2.7 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.

2.8 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.

2.9 RELAYS, CONTACTORS, AND TIMESWITCHES

A. Individual Control Relays (HVAC Plumbing of the Control Functions)
   1. Individual control relays shall have convertible contacts rated a minimum of 10 amperes, 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:

Manufacturer	Type
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, and 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 timeswitches 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 40A per pole.
   a. Exterior lighting timeswitches 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 timeswitches for control of individual circuits or electrically operated relays shall be Tork 7000 Series or approved equal by Paragon or Intermatic.
   c. Timeswitches for control of air conditioning or plumbing equipment shall have seven day dial and shall be Tork WL Series or approved equal by Paragon or Intermatic.
2. All timeswitches shall be mounted in separate section in top of panelboards under separate lockable door unless otherwise indicated on Drawings. Clear opening for timeswitch shall be a minimum of 12-inches by 12-inches.

D. Contactors and/or Relays/Timeswitch Cabinet

1. Contactors, relays, and/or timeswitches 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 timeswitch 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 timeswitches they shall have a clear acrylic shield installed over each relay or contactor to guard line exposed parts from accidental contact by nonauthorized personnel.

2.10 DISCONNECTS (SAFETY SWITCHES)

A. General
   1. Disconnect switches shall all be rated:
      a. 600 volt 60Hz AC for all disconnect safety switches.
      b. NEMA Type HD, quick-make, quick-break, H.P.-rated.
      c. Fused Class "R", in NEMA Type I indoor location enclosure. Where enclosure is indicated outdoor or W.P. (Weather-Proof) switches shall be rain tight NEMA 3R enclosure. Lockable access door.
      d. Number of poles horse power rating 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. 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.
   4. Disconnect switch and fuses ampere rating shall also comply with Manufacturer’s recommendation for the connected load.

2.11 SPARE FUSE CABINETS

Provide a cabinet in each room where a switchboard or motor control center is installed and contains fuses. Cabinets shall be as specified for "Terminal Cabinets" and shall be of sufficient size to contain all spare fuses hereinbefore specified. Provide clips (two per fuse) for each spare fuse. Mount clips in plywood backboard in cabinet. Label cabinet "SPARE FUSES".

2.12 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 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 0.75-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 ⅜-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.

2.13 TRANSIENT VOLTAGE SURGE PROTECTOR (TVSS) – DIRECT CONNECT

A. General

1. The unit shall be modular in construction and operate in parallel with 60Hz AC line voltage, 4-wire or 5-wire, grounded or ungrounded systems, as applicable; voltage, kVA and ampere capacity as indicated on the Drawings. Suitable for direct connection through an external circuit breaker or combination switch/fuse protective device rated 30-ampere, continuous duty, rated for Service Entrance equipment connection. Transient electrical surge protection sequences shall include circuit configurations as follows:
   a. Line-to-Line (Phase-to-Phase).
   b. Line-to-Ground (Phase-to-Ground).
   c. Line-to-Neutral, where neutral is present.
   d. Ground-to-Neutral, where neutral is present.
2. The unit shall operate correctly with any combination of resistive, inductive, or capacitate loads. The unit shall automatically shunt to ground the electrical transients and EMI/RFI noise occurring above the specified values. The unit shall automatically reset after transient condition has passed. Operating temperature minus 40° centigrade to plus 85° centigrade.
3. Provide one or more individual self-contained protection module(s) for each line voltage phase, ground and neutral, suitable for direct connect with line-side C/B protection and disconnect. Provide one spare individual plug-in protection module. Provide incoming line, neutral and ground conductor termination lugs rated CU/AL #14 through #4 AWG. Lugs shall be barriered from and prewired to the respective protection modules.
4. Provide a NEMA twelve housing to contain all unit modules, devices and conductor terminations. The housing shall include a hinged pad-lockable access door.
   a. Flush housing for mounting internally inside related equipment.
   b. Surface mounted, with conduit entrance knockouts for external mounting. Maximum housing size shall not exceed 36-inches wide by 72-inches high by 8-inches deep.
5. As manufactured by Total Protection Solutions Model #ST-TVSS; or MCG Electronics; or Advantage Protection Technologies, Inc.

B. Operational Characteristics

1. Transient voltage protection, testing, listing and certification.
   a. UL 1449 (latest edition) and CSA listed and labeling, for Transient Voltage Surge Suppresser, UL 1283 for transient voltage electrical noise attenuation, ANSI/IEEE C62.45, C62.1 for C62.41, (latest edition) bi-directional transient clamping voltages for both Normal Mode and Common Modes against Category A and B ring wave and Category B impulse wave.
   b. The unit connected to the service entrance shall also withstand a minimum of 2000-sequential ANSI/IEEE C62.41 Category C surges without failure following IEEE Test procedures in C62.1, C62.41 and C62.45.
2. Transient voltage protection, EMI noise rejection, and RFI noise rejection shall be provided for Common Mode (line-to-neutral and line-to-ground), Normal Mode (line-to-line) and neutral to ground.
3. EMI and RFI noise rejection.
   Conducted line noises interference both Electromagnetic (EMI) and Radio Frequency (RFI) shall be reduced by the unit over a continuous spectrum of 0.5MHz to 1.0MHz. The basis for reduction shall be a standardized 50-OHM insertion loss MIL -STD-220A test. Provide Spectrum Analysis Test dB attenuation reports showing RFI filtering over specified frequencies. Test data based on calculated or computer simulation is not acceptable.
4. Three phase and grounded "WYE" performance requirements.

Characteristics	208/120 Volt	480/277 Volt
Nominal line-to-line	208 Volt	480 Volt
Nominal line-to-neutral	120 Volt	277 Volt
Internal capacitance (Microfarads)	2.5	2.5
Maximum response time	1-nanosecond	1-nanosecond
EMI/RFI noise rejection	25-35dB	25-35-dB
Nominal peak clamp voltage Line-to- neutral and line-to-ground	500 Volts	900 Volts

Minimum transient energy dissipation per phase (at 8x20 microseconds waveform)	1000 Joules	1500 Joules
Peak transient withstand (at 8x20 micro-seconds waveform) without failure of the unit	50,000 Amp	60,000 Amp
· Category-C3	300,000 Amp	500,000 Amp
· Category-B3	100,000 Amp	150,000 Amp
· Category-A3	60,000 Amp	80,000 Amp

C. Diagnostic Indicators
   1. Shall display the "Normal" and "Fault" status of each line suppression circuit, along with protection circuit "on" indication.
   2. Shall provide a sonic audible fault alarm with silence push-button

D. Surge Suppressor Protection Categories
   1. Surge protectors shall comply with ANSI C62.41 (Latest Revision) Standard Protection Categories for "impulse" and "ringwave" transients, based on the installation locations shown in the Contract Documents.
      a. Service entrance, main switchboard or substation locations - Category "C3", high exposure, Type-1.
      b. Mid building, distribution panels, distribution panels over 400-ampere main bus rating locations - Category "B3", high exposure, Type-1.
      c. Branch circuit panelboards 400-ampere or less main bus rating - Category "A3", high exposure, Type-1.
   2. The TVSS short circuit current withstand rating shall exceed the actual short circuit current available at the TVSS installation location

2.14 PLUG STRIP TRANSIENT VOLTAGE SURGE SUPPRESSOR

A. General:
   1. Point-of-Use Type-3 self-contained unit rated 15-ampere, nominal 120 volt plus-or-minus 10%, 60Hz, AC, 1875 watts full continuous load. Internal 15 ampere resettable overload protection circuit breaker. Red illuminated on-off switch. 6-foot, 14 AWG 3-conductor, grounded, heavy duty jacketed AC line cord with NEMA 5-15 cap. Multi-outlet receptacles, suitable for use with the following types of plug in loads, data processing equipment, audio/video equipment, test instruments, medical equipment, photo graphic equipment and "switching type" power supplies.
   2. Protected outlets shall be NEMA 5-15R 15-ampere, AC 60Hz receptacles. Provide 4 protected outlet plugs on each plug strip, as indicated on the Drawings. Each group of two receptacles (duplex) shall be connected to separate protected load isolated filter banks. Each duplex shall be isolated from the other output receptacles, minimum isolation of 25dB at 1MHz line to line, line to neutral, line to ground and neutral to ground.
   3. Non-blocking plug-in locations/orientation for plug-in "power-brick" power supplies, without obstructing adjacent receptacles.
   4. As manufactured by TRIPP LITE-Isobar Series; or Advanced Protection Technologies; or equal.

B. Operation:

   Self-contained RFI and EMF shielded housing with mounting slots for temporary mounting of the unit. Protected outlet receptacles shall supply filtered, electrical line voltage power to the connected equipment. Line noise RFI and EMI interference filtering suppression, transient voltage surge and spike protection shall occur in all three modes of operation line to ground, line to neutral and neutral to ground rated as follows:
   1. 13,000-ampere, 210 joules (watt-seconds) peak withstands capacity.
   2. Transient response time less than 5-nano seconds.
   3. 140-volt AC RMS initiate spikes suppression 330 volt maximum let through.
   4. RFI and EMI Suppression-Provide Spectrum Analysis Test dB attenuation reports showing RFI filtering over specified frequencies.
      50KHz greater than 20dB
      150KHz greater than 40dB

1MHz greater than 80dB

5. Diagnostic indicator lights located on the TVSS housing shall provide alarm alert for each of the following conditions:
   a. Loss of AC power.
   b. Damage, malfunction in the TVSS suppression circuits.
   c. Improper AC electrical outlet wiring.
6. Standards Testing, Listing, Labeling and Certification Compliance, latest revisions:
   a. IEEE 587 A and B compliance.
   b. UL 1449 transient voltage surge suppressers.
   c. UL 1363 temporary power taps.
   d. UL 1283 electromagnetic interference filters.

C. Rack Mounted TVSS

1. TVSS units installed in equipment racks shall comply with all of the same performance requirements, except as follows.
   a. EIA/TIA – Equipment rack mount style (19-inches or 24-inches as applicable).
   b. Minimum of two front mounted receptacle outlets and not less than six rear mounted receptacle outlets.
   c. 20 ampere 120 volt 60Hz AC electric circuit rating, instead of 15 ampere..

2.15 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-rain tight, rust inhibitor phosphatizing base coating and baked enamel finish, Manufacturer's standard color.
2. Rain tight 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

3.1 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 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.

C. The Maximum Resistance to Ground shall not exceed 5 ohms.

3.2 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.
    b. Poke-thru floor outlets, core drill floor for installation of poke-thru. Install “split-box” in the ceiling space of the floor below. If the ceiling space of the floor below is not accessible ceiling type (lift-out), then provide 12-inches round removable fire-rated stainless steel access panel and trim-ring in the finish ceiling for hand-access to poke-thru “split-box” above the ceiling.
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.
    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) ⅝-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.

3.3 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 and ARC-Fault devices after installation and circuit connection is complete.
    b. Test all devices for correct polarity and proper electrical energization.
    c. Test On-Off operation of automatically controlled outlets and receptacles.
7. Install and adjust all coverplates to be flush and level, with correct device and circuit 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-ampere 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.

3.4 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. Remove concrete pour-forms.

3.5 TRANSIENT SURGE PROTECTOR INSTALLATION (TVSS)

A. Direct connect TVSS Installation
   1. Install unit cabinet to insure a maximum connected circuit length of less than 5-feet from the equipment the transient surge unit is connected to, approximately plus 48-inches on wall.
   2. Alternately, factory install TVSS unit directly into respective equipment, instead of remote from equipment. Install TVSS inside respective switchgear, switchboards, distribution panels, panelboards, etc.
   3. Connect between transient surge unit and supply equipment with not less than 1.25-inch conduit containing 5#4 AWG, copper conductor, 600 volt THHN /THWN insulation, connection circuit.
   4. Provide a subfeed overcurrent protective device in the respective panel or switchboard to supply the TVSS connection circuit, whether or not shown on the Drawings. The protective subfeed device shall be a thermal magnetic circuit breaker rated not less than 30-ampere 3-pole or a safety switch and fuse unit rated not less than 60-ampere 3-pole, voltage and short circuit fault interrupting class to match the respective circuit voltage.
   5. Connect transient surge unit to main building ground bus or electric distribution equipment ground bus (whichever is closer distance), with 1.25-inch conduit - 1#4 AWG copper conductor 600 volt, THHN/THWN insulation.

B. Plug-in type TVSS
   1. Install in respective equipment racks.
   2. Install at respective workstation locations, cabinets and furniture.
   3. Connect to respective equipment and wall electrical outlets.

C. Install, Connect, and Test each TVSS Unit in Accordance with Manufacturer's recommendations.

3.6 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.

END OF SECTION 260505
062117/1010006

SECTION 260530
CONDUIT AND WIRE

PART 1 GENERAL

1.1 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.

1.2 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

2.1 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 ampere RMS.
      2) 2.0 inch and larger conduit/fitting size - 20,000 ampere RMS.
   b. FMC and LTFMC Conduit Fittings
      1) 0.5 inch through 1.25-inch conduit/fitting size-1,000 ampere RMS (without external bonding jumper).
      2) 1.5 inch through 4.0-inch fitting size-10,000 ampere RMS with bonding jumper.
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 pinholes.

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.
      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 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).
3) Thomas & Betts-5123 (compression type) Series (with 2 locknuts).
4) Emerson-OZ/Gedney-TC600I (compression type) Series (with locknut).
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 — Thomas & Betts-3110 Series (with locknut)
      45 and 90 Degree Angle Connectors — Thomas & Betts-3130 Series (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.
2. The exterior jacket shall be positively locked to the metal core to prevent jacket "sleeving".
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 "sleeving" 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
· Thomas & Betts-5331 GR Series.	Thomas & Betts-5341GR & 5351GR Series.
• Appleton-STB & STN-L Series for use w/ preformed "knockouts".	Appleton-STB-L Series; STN-L Series for use with preformed "knockouts".
· 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.
   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:
   Triple Combi-Duct
   a. Quantity of three continuous round rigid inner linear ducts, nominal size inside diameter 1.5-inch for each inner duct.
   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 conduit 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.
   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.

2.2 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.).

2.3 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.
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.
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, nonsuspended 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.

2.4 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 centigrade.
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
6. Health Care facilities all circuits insulation shall be XHHW-2, rated Hospital-Grade.

7. 600 Volt AC and/or DC insulated conductors installed in open cable tray or open wireway or exposed insulation also shall be rated for exposed install locations.

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:

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

         120/208 Volt
         Provide a continuous stripe on each conductor insulation, orange or yellow, except ground
   2. When individual neutral conductors are shown 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.
   3. Feeders identified as to phase or leg in each, switchboard, switchgear, panelboard and junction location with printed identifying tape.
   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.
   5. Color coding for 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 District's Representative in writing for approval prior to installation.

D. Panel Feeders, Copper or Aluminum:
   1. Wire size shown on the Drawings is for copper conductors, unless specifically indicated otherwise.
   2. If aluminum wire is proposed, increase wire size to ampere capacity of copper wire and voltage drop not to exceed that of copper feeders indicated on Drawings. Increase conduit size and quantity as required by code. Provide feeder calculation sheet, eight copies, if aluminum wire is proposed, showing feeder number, length, size and voltage drop in percentage for original copper feeders and for equal aluminum feeders.
   3. Aluminum Conductors (600 Volt or Less Only): Contractor has the option of using aluminum conductors in lieu of copper conductors for feeders only to panels, distribution boards/panels, switchboards, switchgear, transformers, motor control centers, and dimmer switchboard.
   4. Aluminum Conductors shall be Aluminum Association AA-8000 Series Alloy, compact-stranded, with the same insulation as called for under copper conductors.
      a. Aluminum conductor larger than 750 MCM shall not be used.
      b. Aluminum conductors smaller than #2AWG shall not be used.
   5. If the conductor termination is to be made on a bus bar or similar flat surface, a Burndy Type YA-A HYPLUG compression terminal intended for the specific conductor size, factory filled with oxide inhibitor compound shall be used. Terminal must be installed using a hydraulic compression tool equipment with a die head for the particular terminal used. Only Burndy Hypress tools shall be used for compression.
   6. If the conductor termination is to be made into a circuit breaker or similar insert compartment it shall be terminated by use of a Burndy AYP HYPLUG compression connector intended for the specific conductor size, factory filled with oxide inhibitor compound. Connector must be installed using only Burndy Hydraulic compression tool specifically approved for each respective connector.
   7. Connector aid shall be used for all terminations and connections. Connector aid shall be Burndy Pentrox A, NO-OX-1D Grade "A".
   8. When an aluminum lug is terminated to a copper bus with a steel or copper stud or bolt, place aluminum lug on stud or bolt followed by a flat steel washer, a Belleville washer, and steel or copper nut, in that order.

2.5 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.
   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.

2.6 FLEXIBLE CORDS AND PORTABLE CABLES

A. General
   1. Multi-conductor insulated flexible cable with jacket rated extra heavy duty, extra hard-use and high abuse duty; ozone, sunlight, grease, oil resistant-UL 83 and water resistant; rated for indoor/outdoor use.
   2. Quantity of conductors and conductor sizes as indicated on the Drawings but in no case less than five 16AWG.
   3. Characteristics:
      a. Conductors - stranded copper, soft annealed conforming to ASTM-B-174 and ASTM-B-172. 600 volt individually insulated and color-coded. Separate green insulated ground conductor. Aluminum conductors shall not be permitted for cords and cables.
      b. Insulation - rubber conforming to UL 62; temperature range plus 105° Centigrade to minus 50° Centigrade.
      c. Flame resistance shall conform with MSHA-P123-103.
      d. Jacket - black for equipment connections and yellow for outlet connections. Rated for temperature range plus 105° Centigrade to minus 50° Centigrade, water, sunlight and ozone resistant. Permanently mark jacket a minimum of 40-inches on center with rated voltage, Manufacturer's name, wire/insulation type, AWG conductor size and quantity (minimum 24-inches on center).

2.7 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:

Hook/Arm Length	Min. Weight Each Hook/Arm Supported	Max. Allowable Hook/Arm Deflection
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

3.1 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.

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.

3.2 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.
   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 and Branch Circuit Protection	Min. Equip. Grnd Wire Size
15 Amp	#12
20 Amp	#12
30 to 60Amp	#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.

H. UFER Ground
   1. In addition to all cold water and structural steel grounds provided to meet this specification, there shall be a main ground system of the UFER ground style.
   2. The UFER ground electrodes shall be a minimum of two 20-feet lengths of #4/0 AWG bare stranded copper cable embedded horizontally in the cast in place concrete footing, extending in opposite directions in the footings. All portions of the ground electrodes shall be placed inside the concrete, between 2-inches and 4-inches from the earth surrounding the concrete.
   3. The lengths of cable shall extend in opposite directions in the footings, with the center end of each cable terminated onto the main electrical service ground bus for the main electrical service equipment.
   4. All wire cable connection terminations onto the ground bus shall be exothermic weld type.
   5. The “UFER” grounding electrode, embedded in concrete, shall be exothermically welded to each steel reinforcing bar (rebar) and each steel anchor bolt located within 18-inches of the grounding electrode inside the concrete. Note: Reinforcing steel (rebar), in concrete foundations, attached with metal “tie-wraps” and in direct physical contact to other adjacent rebar that is in turn exothermic welded to the UFER grounding electrode, may be classified as attached to the UFER grounding electrode, and does not require additional exothermic weld connections to the UFER grounding electrode.

I. Provide a separate ground/bond insulated grounding electrode conductor, copper wire from the main electrical service ground bus to each of the following locations. The ground/bond conductor shall be sized to comply with applicable Codes and as indicated on the Drawings, but in no case smaller than the following:
   1. Main service entrance equipment ground bus:
      a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
      b. Services 1200 ampere and larger 2.5-inches conduit with 1#500MCM.
      c. Where a separate ground bus is not required, connect ground to electrical equipment metal housing
   2. Each telephone backboard and signal system backboard location, 1.25-inch conduit with 1#1.
   3. Metal cold water pipe located inside the building, 1.5-inch conduit with 1#4/0.
   4. Outdoor underground metal cold water pipe, make connection five feet from the building, 1.5-inch conduit with 1#4/0.
   5. Each service entrance ground bus and each separately derived ground rod system:
      a. Services smaller than 1200 ampere 1.5-inch conduit with 1#4/0.
      b. Services 1200 ampere and larger 2.5-inches conduit with 1#500MCM.
   6. Separate 1.25 inch conduit with 1#2 (AWG) bonding conductor to each interior metal pipe system located in the same building, including but not limited to, the following:
      a. Fire sprinkler system each stand-pipe location (water based and non-water based).
      b. HVAC chilled water supply and return, at each pump location.
      c. Roof drains.
      d. Waste liquid disposal systems.
      e. Metal gas pipe service entrance and service meters.
      f. Hydraulic elevator hydraulic pipes.

3.3 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.

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 six 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 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-inch 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 Zone 4 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 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 five 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 and 20-ampere 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 ¾-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 10-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 ampere and 20 ampere 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, 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 of 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.
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 underground 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.
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.

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	100 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 on 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.
    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 ±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 personal 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.
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 ⅛-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.

3.4 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 (2) 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.

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.

3.5 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.

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.

3.6 CABLE RACKS

A. General

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

3.7 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 ¼-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.

B. Refer to Section 260500 Common Work Results for Electrical item 1.13 for Testing requirements.

END OF SECTION 260530
062117/1010006

SECTION 260533
MANHOLES AND PULLBOXES

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all racks, hooks, supports, ladders, covers, grounding, manholes, vaults, pullboxes, joint sealing compound etc.

B. Submit Detailed Shop Drawings including Dimensioned Plans, Elevations, Details, Structural Calculations signed by a California State Registered Structural Engineer and descriptive literature for all component parts.

PART 2 PRODUCTS

2.1 MANHOLES

A. Each concrete precast section shall be identified by having the Manufacturer's name and address, along with respective section weight cast into an interior face or permanently attached thereto.

1. As manufactured by Jensen Precast Products; or Shaw Concrete Products, Utility Vault Products; or equal.

B. Material and Fabrication

1. Precast, rectangular, with round opening, designed for H-20 bridge loading. Complete with extension and cover.
2. Cast iron cover and frame, 30 inch diameter by Alhambra Foundry, as detailed on Drawings.
3. Provide cable racks spaced evenly at approximately 2 feet-6 inch intervals around interior of communication and power manholes and grounding as indicated on Drawing Details.
4. Not used.
5. Manholes shall be constructed of reinforced concrete, 5500 psi at 28 days minimum. Vertical clearance from finished floor to ceiling shall be as indicated on Drawings. A minimum of four straight walls shall be provided for cable splicing area or as shown on Drawings.
6. Duct entrances into manholes shall be so located that sharp bends of cable at duct mouth will be unnecessary. Duct termination in manhole shall be made with end bells as indicated on Drawings.
7. Frames and covers shall be made of cast iron. A recessed seat shall be provided to ensure a perfect joint between frame and cover. Frames shall be given two coats of asphalt paint. Covers shall be cast with the lettering "H.V. Electric" to denote electrical or “Communication” to denote communication, and manhole ID number stamped into frame ring as indicated on Drawings. In paved areas, top of manhole covers shall be installed flush with finished surface of paving. In unpaved areas, top of manhole covers shall be installed approximately ½-inch above finished grade. Where existing grades that are higher than finished grades are encountered, a sufficient number of courses of brick shall be used between top of manholes and manhole frame to elevate temporarily the cover at existing grade.

8. A sump shall be provided, minimum size 12 inches x 12 inches x 5 inches or a 5 inch deep, 13 inches round encased in floor of manhole with recessed grated cover plate as indicated on Drawings.
9. Pulling eyes made of heavy galvanized steel spider inserts welded to rebar shall be cast in the concrete walls below and opposite each ductbank entrance and in the ceiling above each ductbank entrance and as indicated on Drawings.
10. In each manhole as indicated on Drawings, a ¾-inch x 10 foot copper-clad steel ground rod shall be driven into the earth. Approximately 6 inch of rod will extend above manhole floor for ground grid. A manhole ground grid shall be installed using a 4/0 AWG stranded bare copper ground cable installed on cable racks as indicated on Drawings. Each ductline ground wire shall be connected to this manhole grid using an exothermic weld connection. The manhole ground grid shall be connected to the manhole ground rod using an exothermic weld.
11. In each manhole, include one access ladder, size to match depth of manhole as indicated on Drawings.
12. Provide a 6 inch base of ¾-inch crushed rock under manhole and slab box to ensure uniform distribution of soil pressure on floor.
13. Place and align precast manholes and slab boxes to provide maximum horizontal tolerance of 2 inches in any direction and vertical alignment with not greater than ⅛-inch maximum tolerance for 6 foot of depth. Completed manhole shall be rigid, true to dimensions and alignment, and shall be watertight.
14. Excavate, backfill, and compact in accord with Section 02320.
15. Seal manhole and slab box section joints with sealing compound furnished by the Manhole Manufacturer.
16. Provide conduit duct plugs for all unused terminator openings or spare conduits in manhole and slab box.
17. Give frames two coats of asphalt paint.
18. Interior walls and ceiling shall be primed and painted with two coats flat white paint as follows:

	Manufacturer				
Product Description	Dunn-Edwards Corp.	Frazee Industries, Inc.	ICI Delux Paints	Sherwin-Williams Co.	Vista Paint Corp.
First coat (primer): Water-borne, epoxy concrete sealer	W709	266	36	B42WW49	4600
Second and third coats (finish): Exterior, 100% acrylic flat latex	W701	203	1300	A6 Series	2000

19. Duct and conduit penetrations or plastic terminators into manholes and/or boxes shall be sealed against water intrusion by concrete grouting or mortaring of any gaps that may have occurred during ducts installation. All duct windows shall be sealed around all ducts and end bells to form a watertight window.
20. Sumps shall be knocked out at time of installation.

C. Intercept Manholes/Pullbox Structures

1. Intercept type manhole/pullbox structures shall comply with the requirements of non-intercept manholes and pullboxes, respectively. Plus the additional requirements listed below.
2. Manholes/pullboxes shown to be installed at the same location as replacement for existing manhole/pullbox shall be custom fabricated "intercept" multi-section type.
3. The structure shall be provided with multiple, vertical and horizontal custom fabricated sections for fitting around existing manholes/conduits/duct banks/conductors entrances into the structure during manhole installation without disturbing existing manholes/pullboxes. The structures shall allow placement of the structures without disconnecting or disrupting existing circuits during the installation. The structure walls shall be slotted to fit around existing concrete encased conduit entrances.
4. Provide cast-in-place concrete steel reinforced foundation/footings and floor for the intercept structure. The foundation shall be installed prior to removal of existing manhole/pullbox. The floor shall be installed after removal of the existing manhole/pullbox structure. The foundation/ footing and floor shall be designed, and engineered as part of precast structure.
5. The structure foundation/footings shall be "keyed" to match keying of manhole precast wall sections.

2.2 PULLBOXES

A. Pullboxes shall have deep recess conduit knockout concrete extensions at two opposite end walls. Additional shallow recess knockouts shall be provided on the other two walls for conduit entrances.

B. Pullboxes shall be provided with a minimum of one precast concrete 6-inch extension grade ring "tongue and groove" matting surfaces to insure rigid assembly.

C. Pullbox Sizes shall be as indicated on Drawings but in no case less than required by applicable Codes. Minimum depth of the pullbox shall not be less than 42-inches.

D. The Pullbox Floor Sump shall extend through the concrete floor into the gravel bedding, below the pullbox.

2.3 COVERS AND FRAME ASSEMBLIES

A. Traffic Rated per AASHO for H20 Loading
   1. Covers shall comply with Federal ADA, UL, State, and Local AHJ for slip resistance.

B. Pullboxes
   1. Hot dip galvanized steel single piece flush fitting with threaded flush hold down, slotted head, stainless steel studs.
   2. Topping frame shall be hot dip galvanized steel angle frame where the pullbox is installed in paving or concrete work.
   3. Top ring frame shall be armor band type where the pull box is installed in exposed earth or landscaping.
   4. Cover openings larger then 5-square feet of surface area, shall be provided with "split" two piece cover type. Each "split" cover shall be hinged open-close with Torsion-Spring type cover, to assist in the ease of opening and closing the cover.
   5. Cover openings 5-square feet or smaller surface area shall be single piece covers.

C. Covers shall be permanently marked in the cover metal as follows:
   1. "E" or "Electric" for covers on structures containing power circuits under 600-volts and "HV" or "High voltage" for covers on structures containing power circuits over 600 volts.
   2. "Signal" for covers containing signal circuits.

2.4 CABLE RACKS

A. 5/8-inch diameter anchor bolts and concrete inserts to support each cable rack as indicated.

B. Use Inwesco cable rack for each manhole as indicated (length to fit).

C. Use Inwesco cable hooks to mount on each cable rack. Type and length as shown on Plans.

D. Use T&B tie wrap, self-locking, cable ties No. TV528MX, two per insulator, to secure cable to cable hook and cable insulator.

E. Use Inwesco Cat. No. 11A31 porcelain insulators spaced equally distant on each cable hook indicated.

F. Mechanically attach cable racks in as indicated to the concrete side walls with approved masonry fastener or bolts. Racks and support arms shall be hot-dipped galvanized steel construction. Support arms shall be equipped with porcelain, saddle type, double hook insulators. All fastening hardware, bolts, washers, and nuts shall be galvanized steel.

G. Each Rack shall contain adjustable heavy-duty support arm(s) of the number indicated on Drawings.

H. Each Support Arm shall contain a minimum of three each porcelain insulators placed on bracket so that top surface of insulator will be in contact with cable PVC jacket. Use of supporting members

made of metallic or other conducting materials in actual physical contact with the cable jacket is prohibited.

I. Ground all cable racks, supports, metal conduits, and the like as indicated.

2.5 PULL-IN-IRONS

A. Pull-In-Irons shall be a galvanized steel bar bent in a "U" shape, and cast in the structure walls and floors.

B. A Floor Pull-In-Iron shall be centered under the manhole entry ring in the structure floor.

C. Pull-In-Irons shall not be less than 6-inches above or below, in the opposite wall from each knockout panel for conduit/duct entrances.

D. Pull-In-Irons shall project from the structure wall into the structure approximately 4-inches.

2.6 DRAINAGE SUMPS

A. Provide drainage sump with cast iron metal grate in the floor of each structure. Minimum diameter of 12 inches by 4-inches deep. Provide a removable cast iron grate over the sump.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate for installation of precast structures removes excess excavated material from the site. Saw cut existing paving and concrete as required for excavation.

B. Provide a minimum of 6-inches deep bedding base of the crushed rock 3/8-inch - ½-inch size in the bottom of the excavation. Bedding shall be level and well compacted by a minimum of four passes with a plate type mechanical vibrator.

C. Back fills and compact earth around precast structure after installation of the structure to 90% minimum compaction in 12-inch lifts. Replace paving concrete, landscaping above structure to match existing.

3.2 INSTALLATION

A. Install precast structures per Manufacturer recommendations to provide a dry watertight installation. Set cover flush with existing grade or finish surface. Where precast structure is installed in pedestrian walkway or vehicular traffic way with a sloping finish grade. Slope cover to match existing finish surface slope.

B. Install structures to avoid surface water drainage flow lines, and existing utilities.

C. Exterior concrete walls, tops, necks and bases of precast structure shall be wet-proofed with two coats of a bituminous for concrete wet-proofing material, minimum finish thickness not less than 0.10 millimeters.

D. Connections to Precast Structure

1. Lines connecting to precast structures shall be constructed to have a cast in place concrete tapered section adjacent to the structure and extending a minimum of 48-inches out from the structure to provide shear strength.
2. Precast structure shall be constructed to provide for keying the concrete envelope of the conduit/duct line into the wall of the structure. Mechanical vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the precast structure.

E. Entrances of conduits/ducts shall terminate with endbells inside the precast structure. Slope conduit entrances into manhole to insure top of conduit entrances into manhole are a minimum of 6-inches below manhole ceiling. Maximum conduit slope shall not exceed 1-inch per "running" foot of conduit.

F. Manholes and pullboxes shown to intercept existing conduit, remove portion of existing conduit approximately 4-feet back from manhole wall, regrade and excavate conduit entrance and extend existing conduit into manhole or pullbox to match existing conduit quantity and size. Provide "horizontal, split" conduit and split conduit coupling to extend existing conduit into manholes and pullboxes.

3.3 GROUNDING

A. Provide 10-feet long by 0.75-inch diameter copper clad, steel, driven ground rods through the floor of the precast structure. Provide a minimum of two ground rods in opposite corners in manholes and vaults, one ground rod in pullboxes. Ground rod shall extend 6-inches above the floor line. Where rock bottom is encountered, bury ground rod in horizontal trench with projection into precast structure. Seal off openings around ground rods.

B. Ground permanently and effectively together all metal equipment cases, metallic, cable racks, ladders, etc., with #4 bare copper bonding conductor. Provide UL compression bonding fittings at each ground connection.

END OF SECTION 260533
022316/1010006

SECTION 260543
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Product Data Sheets.

B. Submit Detailed Shop Drawings including Dimensioned Plans, Elevations, Details, Structural Calculations signed by a California State Registered Structural Engineer and descriptive literature for all component parts.

1.3 SECTION INCLUDES

A. Concrete Encased Ductbanks where indicated on Contract Drawings.

B. Trenching, Backfilling, Compacting, and Concrete Encasement for all 600V, 4.16kV and 12kV Ductbanks shall be required.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Excavating and Backfilling for Utilities: Division 31.

B. Concrete: Division 03.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Duct, Fittings and Spacers:

1. Carlon, an Indian Head Co.
2. Queen City Plastics, Inc.
3. Robintech Inc.
4. R & G Sloane Manufacturing Co. Inc.
5. Allied Tube and Conduit.

2.2 MATERIAL AND FABRICATION

A. PVC Duct Schedule 40 (UL listed only): Manufactured in accord with NEMA Standard TC-2 and WC-1094 Specifications.

1. Cemented fittings.
2. Spacers: Vertical and horizontal interlocking duct spacers for concrete encasement: High-impact styrene.
3. Riser sweeps for power and communication ducts shall be rigid galvanized steel or Schedule 80 PVC.

B. Rigid Steel Conduit, Elbows and Nipples:
   1. Threaded, hot-dipped galvanized conduit manufactured in accord with ANSI C80.1 and UL 6.
   2. Threaded, hot-dipped galvanized fittings manufactured in accord with ANSI C80.4.

PART 3 EXECUTION

3.1 INSTALLATION

A. Excavate in Accord with Division 31.

B. Exercise Care in Excavating, Trenching, and Working near Existing Utilities.

C. Installation of Ductbanks:
   1. Ductbanks for primary electrical power and communication systems shall consist of multiple, single, round bore ducts. Ducts shall consist of PVC Schedule 40 conduits, UL approved only. All fittings and couplings shall be of the same type and Manufacturer of the duct, with UL approval.
   2. Galvanized steel conduits installed below grade shall be painted with two coats of Koppers bitumastic paint before installing in ground.
   3. All conduit risers into switchgear pad, transformer pad, communication pull boxes or enclosures shall be galvanized steel and have a radius of 60 in. minimum, unless indicated otherwise on Drawings.
   4. Concrete encased ductbank shall be completely encased in a minimum of 3 inches of concrete. Concrete shall be Class "B" red tint for 4.16kV and 12kV power and green tint for communication (6 lb. tint per cu. yd.), 2500 psi at 28 days. Ductbanks shall be of a monolithic construction top to bottom and side to side, but not necessarily end to end. All PVC duct shall be protected prior to installation.
   5. Prefabricated, interlocking intermediate and base spacers for Schedule 40 PVC conduit shall be used, made of Specification grade high-density polyethylene. Spacers shall be installed not more than 5 feet center-to-center along entire length of ductbank. Each conduit shall be supported by spacers.
   6. At connection to manholes, dowel concrete encasement with one No. 4 reinforcing bar 36 inches long per duct.
   7. Ductbanks shall be securely anchored to prevent movement during placement of concrete.
   8. Where connection to bulkhead of ductbank is made to vaults or existing ductbanks, the concrete encasement shall be doweled with one No. 4 reinforcement rod 36 inches long per conduit to the existing encasement.
   9. Ductbank trench shall be shored, framed and braced for installing ducts. Frames, forms, and braces shall be either wood or steel. Variations in outside dimensions of the completed ductbank shall not exceed 2 inches on the vertical or the horizontal from dimensions shown on Drawings. Remove all forms and bracing after 24 hours and before backfilling.
   10. Do not place backfill for a period of at least 24 hours after pouring of concrete.
   11. Ductbanks shall be laid to a minimum grade slope of 4 inches per 100 feet. This slope may be from one manhole to the next or both ways from a high point between manholes, depending upon the contour of the finished grade. See respective Profile Drawings.
   12. Ductbanks shall be installed so that the top of the concrete encasement shall be not less than 48 inches below finished grade or pavement for primary 12kV power, and not less than 36 inches below finished grade or pavement for 5kV power.
   13. Changes in direction of runs either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of 30 feet, except that manufactured long radius bends may be used in runs of 100 feet or less on approval from Owner.
   14. Duct joints in concrete encasement may be placed side by side horizontally, but shall be staggered at least 6 inches vertically. All joints shall be made in accord with Manufacturer's recommendations for the particular type of duct and coupling selected. In the absence of specific recommendations, various types of duct joints shall be made by the following method:
       a. Plastic duct connections shall be made by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of duct's ends. The duct and fitting shall then be slipped together with a quick one-quarter turn to set the joint.

15. The electrical system ground conductor shall be a minimum No. 4/0 AWG bare stranded copper cast in ductbank 3-inches below top of concrete, entering each manhole, and grounded to a rod using exothermic method as indicated on Drawings. The electrical system ground shall be connected to substations ground loops. A minimum of 15 feet pigtail shall be provided at each stub-up location noted on Drawings.
16. After the duct line has been completed, three each nonflexible mandrels not less than 12 inches long having a diameter approximately ¼-inch less than inside diameter of the duct shall be pulled through each duct; after which a brush with stiff bristles shall be pulled through each duct to make certain that no particles of earth, sand or gravel have been left in the line. Leave a 3/8-inch minimum polypropylene pull rope in each duct for future use.
17. Underground utilities marking: Install in accord with Division 31.

END OF SECTION 260543

022316/1010006

SECTION 260548
SOUND CONTROL

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Comply with Pertinent Provisions of Division 26.

B. Submit Product Data Sheets for Vibration Isolation Devices.

C. Submit Detailed Shop Drawings including Dimensioned Plans, showing equipment vibration isolation anchoring.

PART 2 PRODUCTS AND EXECUTION

2.1 QUIETNESS OF OPERATION

Before the work will be accepted as complete, quietness of operation, to a degrees satisfactory to the Architect, shall be attained for apparatus, equipment, fixtures, etc., included under the electrical work. Provide isolation and vibration protection required.

2.2 VIBRATION ISOLATION FOR ELECTRICAL EQUIPMENT

A. Objective: It is the objective of this Specification to provide the necessary design for the avoidance of excessive noise or vibration in the building due to the operation of machinery or transformers, and/or due to interconnected conduit.

B. Contractor Responsibility

1. Provide a submittal to the Architect for review prior to any installation of his equipment, containing the following information:
   a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the Specification.
   b. An itemized list showing the items of equipment to be isolated, the isolator loading and deflection and isolator placement.
   c. Drawings showing methods for attachment of conduit to motors.
2. Furnish and install the vibration isolation devices as specified herein.
3. Do not install any equipment or conduit as specified in the schedule, which makes rigid contact with the “building” unless it is approved in this Specification, or by the Architect. "Building" includes slabs, beams, studs, walls, lath, etc.
4. Coordinate work with other trades to avoid rigid contact between equipment for conduit as specified in the schedule and the building. Inform other trades following his work, such as plastering, to avoid any contact that would reduce the vibration isolation.
5. Bring to the Architect's attention, prior to installation, any conflicts with other trades which will result in unavoidable contact to the equipment or conduit as specified in the schedule, described herein due to adequate space, etc. Corrective work necessitated by conflicts after installation shall be at the responsible Contractor's expense.

6. Bring to the Architect's attention any discrepancies between the specifications and field conditions, changes required due to installation. Corrective work necessitated by discrepancies after installation shall be at the Contractor's expense.
7. Obtain approval from the Architect of any installation to be covered on enclosed, prior to such closure.
8. Obtain written and/or oral instructions from the Vibration Isolation Manufacturer as to the proper installation and adjustment of vibration isolation devices.
9. Notify the Architect, prior to the general installation of vibration isolation devices, so that the Architect can instruct and demonstrate the technique of proper installation with the Contractor's Foreman.
10. Correct, at no additional cost, all installations, which are deemed to be defective workmanship or materials by the Architect.

2.3 VIBRATION ISOLATION TYPES

A. Isolator Description
   1. Isolate all transformers with Type MN molded neoprene units equipped with leveling bolts and design status deflection under load of 0.3-inch.
   2. Isolate all switchgear connected directly to transformer with Type PN isolators. Limit loading to a static deflection of 0.06 inch. Choose the area of pad to match the load with the Manufacturer's recommended unit loading. An auxiliary steel plate may be required to distribute the load uniformly over the pad area.

B. Equivalent Vibration Isolators

1. Type Description	A	B	C	D	E	F	G
Neoprene Mount							
a) 0.2-inch max. deflection	N	FD	R	RV	CS	F	T-44
b) 0.4-inch max. deflection	ND	FDD	RD	RFD	FU	RD	T-44
PN Neoprene Pad	W	(1)	(2)	NR	R	(3)	100W

2. Notes
   (1) Elastrogrip
   (2) Shearflex
   (3) Kinetic

Manufacturer's Code
A. Mason Industries
B. Korfund
C. Vibration Mounting
D. Amber/Booth
E. Sausse
F. Consolidated Kinetics
G. Vibration Eliminator

2.4 CONDUIT INSTALLATION

A. Provide flexible conduit or an approved vibration isolation device between any transformer and the building structure.

B. Secure all electrical panels connected to transformers by flexible conduit to the floor. Do not contact stud or masonry partitions. Isolated panels from the floor as specified herein.

C. Provide flexible conduit connections to all connections to air conditioning, plumbing, etc., or any rotating or oscillating equipment requiring electrical motors. Base the length of flexible conduit required for each motor upon the requirements for a 360 degrees loop in the conduit between the electrical motor and electrical box.

D. As an alternative to the 360 degrees loop, a Neoprene or rubber bushing between the conduit and the electric motor to break the metal-to-metal contact may be used. Provide a flexible ground strap to complete the electrical ground.

2.5 DEVICE OUTLET BOXES (INSTALLED IN COMMON PARTY SEPARATION WALLS, IN CORRIDOR WALLS AND SERVICE WALLS)

Device outlet boxes installed in walls shall be sealed on the exterior back and sides of the boxes, including wall openings around the box, with a ⅛-inch minimum thickness resilient sound absorbing, sealant. The sealant shall be free of asbestos, temperature rated from -30°F to 200°F, self-adhesive to metal and plastics, as manufactured by Lowry and Associates Inc. Sun Valley, California or equal.

END OF SECTION 260548

022316/1010006

SECTION 260910
SUPPLEMENTAL METERING AND SUB-METERING

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide Schematic Control Wiring Diagrams and "Point-to-Point" control wiring diagrams showing control and protective systems interlocks.

B. Provide Nameplate Engraving Schedule.

1.3 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

A. The Equipment shall be designed, tested and assembled to comply with ANSI, IEEE, and NEMA and UL.

1. UL 1244 Electrical and Electronic Measuring and Test Equipment.

PART 2 PRODUCTS

2.1 GENERAL

A. Function

1. Electronic digital metering, microprocessor based data measurement and data recording of simultaneous occurring continuously operating analog conditions, simultaneously with data recording of individual occurrence instantaneous events.
2. The supplemental metering is secondary to the utility revenue metering, as separate independent sub-metering systems. Shall provide tracking of the status, consumption and flow of the unit-values monitored by the respective supplemental metering systems.
3. The meters shall connect analog to digital, not less than 24-bit analog to digital conversion, certified to National Accuracy Standards. UL listed and labeled. Provide local readable visual meter displays, local digital data storage and digital data communications with remote locations.
4. Measurement accuracy shall be better than 0.5-percent and comply with IEC687 (Class 0.5 percent) and ANSI C12.20 (class 0.5 percent). Combined meter and current transformers and related software systems operational accuracy for the electrical power sub-metering systems shall comply with ANSI-C 12.20 and the Public Utility Commission revenue grade accuracy compliance. The sub-metering systems accuracy shall also comply with Savings-by-Design program requirements and U.S. Green Building Council program requirements, including but not limited to the following:
   a. + 0.5-percent at 1.0 power factor and 1-percent through 100-percent of rated current.
   b. $\pm$ 0.75-percent at 0.5 power factor and 1-percent through 100-percent of rated current.
5. Front of meter operator control of meter functions.
6. Ambient operating temperature range minus 15-degrees centigrade to plus 50-degree centigrade.
7. Flammability rating UL94-5V, self-extinguishing, non-flame propagating.

B. Sub-Metering Communications

1. Each meter shall provide full duplex bi-directional network communications. Shall provide connection ports for laptop portable computer/PDA and for remote data collection and monitoring.
2. Provide the following wired meter network connections in each meter
   a. EIA RS-485 serial port for direct connect locally at each meter.
   b. IEEE compliant TCP/IP Fast Ethernet, with RJ-45 port connect and with Power-Over-Ethernet (POE) for remote communications at each meter.
3. Meters shall record and store monitoring data in static non-volatile memory. Not less than 60-calendar days of memory storage capacity. The stored data shall be available for local display on operator demand at the meter and for downloading from the meter by the following.
   a. Portable laptop computer/PDA connected (plug-in) to the meter communication port.
   b. Metering communications network for Automatic Metering Reading-AMR from remote locations using the metering LAN network.
4. Meter electrical operating power.
   a. Provide meter internal electrical power supplies, batteries shall not be the source of normal meter electrical power.
   b. Meters monitoring electrical power circuits shall connect to the monitored electrical circuit for meter operating power. Provide protective fusing.
   c. Meters monitoring non-electrical systems shall operate on 120 volt 60Hz AC branch circuit electrical power.
5. Bi-directional monitoring for Net-Metering applications.

2.2 ELECTRICAL POWER METERING

A. General

1. The meters shall be microprocessor controlled, digital, measuring and indicating meters.
2. Meter enclosure nominal size 8-inches x 8-inches by 4-inches deep, surface mounting, self-contained, dust proof, insulating electrical housing.
3. The meter shall be rated for direct circuit connects up to 600 volt AC. Single-Phase; Three-phase “WYE” or “Delta” to match the monitored circuit configuration. Provide bus-tap voltage, with current limiting 15-ampere 3-pole circuit breaker or 2-pole circuit breaker, as applicable.
4. The meter shall accommodate input connect through split core instrument Current Transformers (CT). Provide a CT for each phase, compatible with the install location. Three CT’s for three-phase systems and two CT’s for single-phase systems.
5. The meter shall be compatible with the input voltage, CT input/output ratios.
6. Shall provide proper operation over distance of up to 100 feet meter wiring circuit length from the meter to the respective CT location.
7. Meter withstand ratings:
   a. Continuous current overload 100-percent.
   b. Surge 10-times rating for 3-Seconds
8. As manufactured by Electro Industries-Shark Series; or Integrated Metering Systems Inc. – IMS; or E-Mon D-Mon electric sub-meters.

B. Meter Monitoring and Measurements Range.

1. The meter shall provide multi-function monitoring for three-phase and single-phase as applicable.
   a. Real time kilowatt kW load
   b. Cumulative kilowatt hour kWh load
   c. Peak kilowatt demand with time and date adjustable window of 15-minute or 30-minute intervals
2. Direct-read at each meter location, 8-digit LCD visual display of measured data parameters.

2.3 AUTOMATIC METER READING-AMR

A. General

1. Remote AMR communications data recovery and data analysis from the Sub-meters shall occur by the following methods:
   a. Wired meter communications LAN network.

b. Typical for switchboard Owner metering and panelboard Owner metering.
2. The monitor and communications software shall communicate with the Supplemental Metering and Sub-metering system using the AMR communications pathways.
3. Provide meter LAN Network communications Gateway to translate metering system LAN communications protocols with the communications protocols for the Building Automation System BAS-EMCS. Coordinate with BAS EMCS.
4. Provide communications port-card for the Supplemental Metering and Sub-metering system. The port-card shall connect to the PC workstation computer. Operate and communicate with the metering system and the PC workstation monitoring/ communicating metering software.

B. Wired Meter Communications Meter LAN Network Pathway
1. Wired meter network operating over IEEE compliant TCP/IP Fast Ethernet LAN Network. ANSI/EIA/TIA Category-6, 4-pair UTP with RJ-45 connectors.

2.4 MONITORING AND COMMUNICATING SOFTWARE

A. General
1. The monitoring and communicating software shall provide a complete and comprehensive Enterprise wide operation of the metering system. Provide concurrent multi-user software site license for the entire system.
2. Graphic User Interface (GUI) operation, programming and configuration of meters.
3. Real-time viewing capability, data-logging and viewing of historical logs.
4. Communication with sub-meters through Ethernet TCP/IP, direct (plug-in) Serial port, and remote RF Wireless. Shall operate on pc-computers with Microsoft-Windows© operating system.
5. Provide charting, graphing, and analysis of data. Provide viewing of sub-meter records with comprehensive data analysis.
6. ODBC databases for all collected data.
7. Meter reading full reporting capability, utilizing artificial intelligence to diagnose events and provide possible cause scenarios.
8. Client billing and invoice statements for monthly payment by Clients of consumed measure values.
9. Audible and email alarms of selected conditions.
10. WEB Internet access to all meter data.
11. Install, set up and program all software for a fully functional AMR system.

B. Software Functions
1. Connection between remote meters via Serial, Ethernet, RF wireless or Modem. Shall function with all the meters in the Supplemental Metering and Sub-meter system.
2. Viewing of real-time metered data, configuring of meters, and analyzing of collected information from the remote sub-meters.
   a. View real-time readings of all measured parameters.
   b. Configure and analyze collected data from remote sub-meters.
   c. Collect and archive all data.
3. Computer screen display, graphing and reporting functions for collection and archiving of data. ODBC-compliant database structures, stored metering information integrated automatically into other 3rd party software packages. Shall also support .csv file format, auto-configurable. Real-time viewing capability shall include:
   a. Volume, flow, voltage, current, power, and energy
   b. Time of usage and accumulations
   c. Alarms and limits
   d. Max. and min. for each parameter
   e. I/O device information
4. Real-time viewing of data in graphical format. Charting and graphing functions access to any desired data analysis.
   a. Calculation of power quality on a scatter graph
   b. CBEMA plotting information
   c. 3D plots and histograms provided to aid in determining frequency and severity of monitored events.

d. Graphical data analysis by the base software.
e. Viewing of stored waveforms, events caused by monitored system problems, faults, transients, and other conditions.

C. Reports
1. Reporting software shall provide a comprehensive report on each meter, making use of Artificial Intelligence (AI) technology to diagnose the events and provide the possible cause of the event.
2. AI generated industry accepted solution as a result of the analysis of the monitored event. The AI program of the reporting software package shall make use of Fuzzy Logic, Neural Networks, embedded knowledge, and embedded rules to generate correct analysis and solutions.
3. Create tenant billing invoice statement for individual tenant consumption of measured values by the sub-metering system.
4. The software shall have a primary Reports server and a Standby Reports server. If the primary server is not running, the user shall be capable of connecting to the standby server.
5. User specify report writing at project startup or other user-defined times, or on the occurrence of user-defined triggers or conditions.
6. User specify report printing when run or saved to storage disk for later printing. The software shall allow user to format report variables.

D. Remote Server
1. Shall support the receiving of data strings from remote sub-meters in the field. The software shall check the monitoring system for connected remote sub-meters and assign incoming calls. Display warnings and to send email, pager, or phone notification of alarm conditions.

E. Security
1. The software shall have advanced security features, allowing password protection through up to five levels of privileges. The password protection shall allow restriction of access to specific screens and/or functions.
2. The operator shall be automatically logged out after a specified amount of inactivity time. The software shall still be active, but the user shall be restricted to 0 privilege level access after automatic logout.
3. Shall run as either a service or a shell under Microsoft Windows, to disable switching to other Windows applications while the software is running.
4. Allow disabling of the Ctrl-Alt-Delete shortcut key, to restrict operator access to other Windows applications.
5. Not less than two types of alarms: hardware alarms and configurable alarms. Issue alarms for devices going offline and other hardware conditions. User define alarm conditions for configurable alarms. Allow the following four types of configurable alarms: digital alarms, time-stamped alarms, analog alarms, and advanced alarms. Create a project page to display alarms and allow for operator intervention. Alarms must be able to be ordered into categories for prioritization and display.
6. Online Help functions, including a complete Help guide, navigable with forward and back buttons, an Index, and a Search function. Shall have complete context-sensitive help in all of the development screens.

F. Configuration
1. The software shall contain Wizards that allow quick and easy setup of configurable devices and the main control unit.
2. Shall provide Genies already programmed for metering devices. These Genies shall be configured to access and show real-time readings.
3. Shall contain pre-programmed tags for trending and graphing, reporting, events logging, and alarm conditions.
4. The configuration mode shall use forms and templates for data entry during development.
5. The configuration shall utilize Vectoral Graphics. The end user shall be capable of:
   a. Importing graphics and editing them
   b. Creating custom symbols and other objects and animating them, copying them, and moving them on the screen
   c. Connecting symbols and objects and moving them around on the screen

d. Assigning tags to objects, such as metering devices, to display information and perform functions
e. Creating links to other screens and programs from devices and/or buttons
f. Assigning access rights to objects on the screen
g. Assigning keyboard commands to objects on the screen, activated by clicking on an object, moving over an object, or releasing a “click” on an object
h. Configuring objects to change when the project is in Runtime Mode, or when a pre-defined condition exists, e.g., a metering device has gone offline
i. Assigning actions consequent on an object being clicked
j. Configuring more than one project at a time, utilizing the same workstation

PART 3 EXECUTION

3.1 INSTALLATION

A. A Branch Circuit Breaker shall be provided at the metering location to allow safe access to metering components without powering down the entire electrical system.

B. All Meters, Metering Equipment and Software shall be installed to comply with Manufacturer’s installation instructions and recommendations.

C. Wiring Connects (additional requirements)
1. Provide communication connections,
2. One 0.75-inch conduit with two Category-6 cables, homerun to nearest IDF/MDF room patch panel.
a. From each meter location

3.2 SYSTEM COMMISSIONING AND START-UP

A. Contractor to provide setup, testing and programming of metering system and “Commissioning”. Shall be performed prior to occupancy.
1. Record the “cross reference” or the meter serial number (unique ID), meter point, to monitor load relationship.
2. Check for power to the meter.
3. Check the serial number inside the meter.
4. Open the panel so that all CT’s are visible.
5. Verify the CT ratio and write up the cross reference information for the meter.
6. Confirm the “cross reference”. Turn on a known load in the respective monitor load unit on each phase.
7. Verify the meter’s phase diagnostics for the assigned monitor load. Confirm that there is a significant increase on the load for each phase of the meter point.
8. After phases have been checked and loads are still running, turn off the breaker serving the monitor load and confirm that all loads are disconnected.

B. Test Results:
1. Submit two draft copies of Test results to the Owner’s Representative.
2. After approval submit the test results in two final printed copies and one computer readable copy.

C. Testing shall include testing of Communications between Sub-meters, Communications modules, Transponders, and Remote monitoring AMR locations.
1. Testing shall confirm that all power meters included in cross-reference are properly communicating.
2. Testing shall confirm that remote connection is complete.
3. Testing shall confirm that all Transponders and the networks are communicating properly.

END OF SECTION 260910
022416/1010006

SECTION 260923
OCCUPANCY MOTION SENSORS

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Data Sheets on sensors, wiring diagrams, relays, transformers, junction and outlet boxes, and mounting accessories. Submit wiring diagrams. Submit Agency Certifications/Approvals.

B. Submit Details of Pendant-Mounted Sensor Installation.

1.3 APPLICABLE STANDARDS (ADDITIONAL REQUIREMENTS)

A. General

1. All ultrasonic sensors shall comply with the State of California Safety and Health Requirements. Decibel levels for ultrasonic sensors shall comply with the following Criteria and the State of California Energy Commission for Ultrasonic Emissions:

MAXIMUM DECIBEL LEVELS FOR ULTRASONIC EMISSIONS

Mid-frequency of Sound Pressure Third-Octave Bank (kHz)	Minimum dB Level Within Third Octave Band (in dB reference 20 micropascals)
Less than 20	80
20 or more to less than 25	105
25 or more to less than 31.5	110
31.5 or more	115

2. The Contractor and Manufacturer shall certify in writing that all proposed and installed occupancy motion sensors comply with the Federal Environmental Protection Agency (EPA) and State of California Energy Commission Criteria.
3. Occupancy motion sensors shall be:
   a. UL listed and labeled.
   b. Certified for compliance with Federal-EPA and State of California Title-24 Energy Commission Requirements.

PART 2 PRODUCTS

2.1 MOTION SENSORS

A. General

1. Motion sensors and power supply shall be self-contained. The motion sensors shall be solid state low voltage devices designed specifically for energy conservation lighting control. Combined dual function ultrasonic and infrared motion sensing.
   a. Ultrasonic crystal controlled to within +/- 0.01% motion sensor technology.
   b. Passive Infrared (PIR) motion sensor technology.
2. Occupancy motion sensor shall also include available ambient light sensor, in addition to the motion sensor. The ambient light sensor shall prevent the occupancy motion sensor from automatically turning “on” the respective lighting when the ambient day-lighting intensity detected by photoelectric cell contained in the motion sensor exceeds a selected intensity. The

ambient light sensor circuit shall not control the automatic off function. The ambient lighting intensity detection sensitivity shall be adjustable in the sensor, adjustment range not less than 15 through 140 ambient day-lighting footcandles.

3. Automatic-off: sensor shall automatically turn "off" lighting when there is no movement after the preset time delay interval. Lights shall remain "on" with movement. There shall be a "dead band" time period after the unit turns itself off (because of lack of motion) during which a new motion will automatically turn lights on without the manual switch having to be activated.
4. Automatic-on: Sensor shall automatically turn “on” lighting when movement is detected in the monitored space. Lights shall remain on with movement. An internal control shall provide a mechanism to bypass the automatic-on control feature and allow only automatic-off functions. Where manual on/off [dimming] lighting control switches are shown on the Drawings, in addition to the occupancy motion sensors in the same space, the manual controls shall override the automatic "on" control feature of the occupancy motion sensor. Override of the automatic "off" feature shall not be affected by the respective manual switches.
5. Motion detection sensitivity, time delays to turn "ON" after activation and time delays to turn "OFF, shall be adjustable to ensure there will be no nuisance on/off switching of the lights by the motion sensor while the room is occupied. Adjustable settings shall be tamper resistant, concealed behind an access protection cover.
    a. Fluorescent light fixtures with Instant Start or Rapid Start lamp ballast set the minimum lamp "on" time at not less than 15-minutes. Program Start lamp ballast, set the minimum lamp "on" time at not less than 5-minutes.
6. Automatic self-adjusting Adaptive-Learning for time delay and sensitivity variable conditions in the monitored space.
7. Fail-to-on, the failure of a sensor shall cause the occupancy motion sensor load relay contacts to activate, so the occupancy motion sensor function is automatically bypassed and lighting is turned-on.
8. All occupancy motion sensors shall be provided with an indicator light to display when motion is being detected and the unit is operating correctly.
9. Non-volatile internal memory shall store and maintain in memory all occupancy motion sensor settings during any electric power failure.
10. Where multiple occupancy motion sensors are installed with overlapping monitoring spaces, the sensors shall not cause false triggering or malfunctions to adjacent occupancy motion sensors.
11. Occupancy motion sensors shall incorporate mechanical vibration-damping. The vibration-damping shall prevent normal building vibrations from causing “false” sensor operation.
12. As manufactured by WattStopper; or Leviton; or Hubbell; or Greargate.

B. Area Control Coverage

1. Space coverage of motion sensor transponder shall remain constant after sensitivity control has been set. No automatic reduction/increase in coverage nor sensitivity shall occur when air motion caused by air conditioning or heating fans are in operation nor when the occupancy motion sensor has turned off lighting due to not detecting any motion.
2. Occupancy motion sensors in spaces 300 square feet area or less may be a wall switch mounted unit.
    a. Wall switch sensors shall provide detection of motion at desk top, for up to 300 square feet, 180-degree range within a volume dimension of up to approximately 20-feet by 15-feet by 10-feet high, extending from the wall mounting height of the unit to the finish floor.
    b. Wall switch occupancy motion sensors shall be a minimum load capacity of 500 watts 120V; 1000 watts 277V, but in no case shall the load rating be less than the lighting loads shown on the Drawings.
3. Motion sensors in spaces exceeding 300 square feet in size and where shown on the Drawing as mounted on the ceiling, shall be ceiling mounted. The sensor shall not protrude more than 1.6-inches below the ceiling line.
    a. Sensor area coverage shall be 360 degrees three dimensional diameter surrounding the sensor installation location.
    b. The sensor shall be rated to provide coverage of the space volume/room length/width/ height shown in the contract documents. Provide additional ceiling mounted motion sensors to provide complete coverage of each area.

c. Corridor/hallway sensor area coverage shall not be less than 80-feet linear feet extending from the sensor installation location. Sensor shall be bi-directional or uni-directional to provide complete area motion detection at the installation location shown on the Drawings.

2.2 CONTROL UNITS

A. General

1. Control unit shall be an integrated, self-contained unit consisting internally of load switching control relay(s); internal power supply and power supply transformer. The power supply shall be sufficient capacity to provide low-voltage power to a minimum of two motion sensors.
2. Occupancy motion sensors directly controlling line voltage electrical loads, the line voltage load relay contacts shall be “dry” type electrically isolated, with load ratings as follows:
   a. 15A – 120 volt single phase 60Hz AC.
   b. 15A – 277 volt single phase 60Hz AC.
3. Load relay contacts shall be rated to control load types up to the full ampere rating. Incandescent Tungsten lamps for lighting equipment. Rapid start and instant start and Program Start solid state electronic ballast (both low power factor and high power factor) for lighting equipment.
4. The quantity of individual internal load switching relays shall be not less than the quantity of individual “switchleg” circuits to be controlled shown on the Drawings.

B. Occupancy Management Control/Building Automation

1. Provide each occupancy motion sensor control unit with auxiliary dedicated single pole double throw relay contacts operated by the motion sensors that shall be interfaced with building Energy Management Control/Building Automation (EMCS/BAS) energy management and/or building security systems. Relay contacts serving security function shall activate when motion is detected, regardless of whether the respective room manual light switches are on or off.

C. Occupancy Motion Sensors that Connect to Low Voltage Remote Control Relays (LVRCR) Systems.

1. LVRCR systems and occupancy motion sensor shall be rated and certified by the Occupancy Sensor Manufacturer and the LVRCR Manufacturer for proper operation with the LVRCR control port inputs and the occupancy motion sensor control output interface relay contacts. Occupancy sensor normally open, normally closed, maintained control relay contact, momentary control relay contact, control operation sequences in coordination with the LVRCR requirements for automatic “on and off” load control by the LVRCR.
2. The occupancy motion sensor power supply input, voltage rating and current rating control interface should comply with LVRCR requirements.

2.3 OCCUPANCY MOTION SENSOR HOUSING ENCLOSURE

A. General

1. Enclosures for occupancy motion sensor control units shall be pressed steel or high impact resistant nonflammable non-metallic enclosure. Enclosure finish color white. Semi-flush mounting installation, NEMA I “dead front” construction with mounting plates and barriers to provide separation between line voltage and low voltage wiring.

B. Mounting

1. Flush mounting 4.67-inches square by 2.125-inches deep outlet junction box with extension ring and occupancy motion sensor cover mounting plate.
2. Occupancy sensor shall be semi-flush mount into outlet box with tamper resistant attachment of the sensor and the outlet box.
3. Motion sensor shall be approved for installation in environmental air plenum.

PART 3 EXECUTION

3.1 MOTION SENSOR QUANTITIES AND TYPES

A. General

1. The Contractor shall provide the quantity and types of motion sensors required for complete and proper volumetric coverage without gaps within the range of coverage(s) of controlled areas.
2. Rooms shall be 90% to 100% volumetric coverage of the sensing coverage area, to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). Motion sensing detection coverage shall extend from the finish floor to not less than 48-inches above finish floor.
3. The locations and quantities of sensors shown on the Drawings are diagrammatic and indicate only rooms, which are to be provided with sensors. The Contractor shall provide additional sensors if required to properly cover the respective rooms.
4. Ceiling mounted sensors shall also be pendant-mounted in rooms in which the controlled lighting fixtures are chain, cable or pendant suspension mounted. The mounting height of the sensor shall be approximately 6-inches below the bottom of the light fixtures to be controlled.
5. Wall mounted sensors shall be installed at a height not higher than the bottom of the respective ceiling lighting fixtures. For Wall switches with integrated manual switch for “on” or “off” applications, mounting height shall not exceed 42-inches above finish floor.
6. Occupancy sensors may be affected by various conditions in the room. Make adjustments, change the location and/or type of occupancy motion sensor to obtain proper operation in each specific room location.
7. Install occupancy motion sensors a minimum of 72-inches horizontal distance from environmental air supply/return registers, fans and moving objects.

3.2 SETUP AND TESTING

A. 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 lighting control system.
3. Adjust sensitively, time-delay, location and orientation of each occupancy motion sensor; test each sensor/control unit all in accordance with the Manufacturer’s recommendations. Be certain that no obstructions block proper sensor coverage of detection areas and limit sensor pickup zone to the respective room.
4. 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 operating correctly.
5. Verify interconnections and controls with the:
   a. Lighting control systems.
   b. Security/intrusion detection systems.
   c. Building automation systems (BAS and Energy Management and Control Systems EMCS).
6. Record and document each sensor setup and program setting.
7. Submit written report (6 copies) to District’s Representative certifying commissioning has been performed; all respective systems are operating correctly and documenting all software setup and each device settings.
8. Refer to General Commissioning Section 019113 for additional requirements.

3.3 WIRING (ADDITIONAL REQUIREMENTS).

A. General

1. The Drawings do not indicate the quantity of control wires required between various control points. The Contractor shall provide the quantity and type of control wire required for proper system operation, as recommended by the System Manufacturer. Install all control circuits in conduit.

2. Control wire shall be copper #18AWG minimum, twisted pairs, PVC insulated for control voltage, Color Coded to match relay and switch wiring “pigtail” Color Codes.
3. Network communications wires shall be ANSI/EIA/TIA-568B, 100-OHM, 4-pair shielded twisted pairs STP, Category-5E.
4. Where multiple control wires are installed in a signal conduit or route to a single location provide multi-conductor control cables with outer jacket. Control wires for control of relay controllers which shall be separate twisted shielded 4-wire PVC insulated conductors, with a ground wire and outer jacket for each controller to prevent “RF” inference.
5. Control wire shall be increased in wire gauge size as required to ensure proper system operation and voltage drop over the installation distance shown on the Drawings between equipment and control device locations.
6. Occupancy motions sensor control power shall be powered from line voltage "hot" non-switched, lighting branch circuit. Alternately, control power may be obtained directly from the respective lighting control panel (if available). Provide two additional #12 (AWG) “hot-circuit” and neutral unswitched conductor in conduit homeruns and branch circuits.
7. All wiring shall be installed in conduit.

END OF SECTION 260923
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SECTION 260943
LIGHTING CONTROLS SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Digital-Network Lighting Control System and Associated Components (See Section 09113 for General Commissioning requirements):
   1. Power panels.
   2. LED drivers.
   3. Lighting control modules (Lutron Energi Savr Node).
   4. Lighting management hubs.
   5. Lighting management system computers.
   6. Lighting management system software.
   7. Control stations.
   8. Low-voltage control interfaces.
   9. Wired sensors.
   10. Wireless sensors.
   11. Accessories.

1.2 RELATED REQUIREMENTS

A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

B. Section 265113 - Luminaires, Ballasts, and Drivers - Lutron.

1.3 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; Code of Federal Regulations; current edition.

B. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements.

C. ANSI/ESD S20.20 - Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices).

D. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments

E. CAL TITLE 24 P6 - California Code of Regulations, Title 24, Part 6 (California Energy Code).

F. IEC 60669-2-1 - Switches for Household and Similar Fixed Electrical Installations - Part 2-1: Particular Requirements - Electronic Switches.

G. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements.

H. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test.

I. IEC 61000-4-5 - Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques - Surge Immunity Test.

J. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.

K. ISO 9001 - Quality Management Systems-Requirements.

L. NECA 1 - Standard for Good Workmanship in Electrical Construction.

M. NECA 130 - Standard for Installing and Maintaining Wiring Devices; National Electrical Contractors Association.

N. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; National Electrical Manufacturers Association.

O. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association.

P. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

Q. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.

R. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

S. UL 508 - Industrial Control Equipment; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

T. UL 508A - Industrial Control Panels; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

U. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.

V. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.

W. UL 1598C - Light-Emitting Diode (LED) Retrofit Luminaire Conversion Kits; Current Edition, Including All Revisions.

X. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate the placement of wall controls with actual installed door swings.
   3. Coordinate the placement of daylight sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
   4. Coordinate the work to provide luminaires and lamps compatible with the lighting controls to be installed.
   5. Notify Architect of any conflicts or deviations from the Contract Documents to obtain direction prior to proceeding with work.

B. Pre-Wire Meeting: Conduct on-site meeting with Lighting Control System Manufacturer prior to commencing work as part of Manufacturer's standard startup services. Manufacturer to review with Installer:
   1. Low voltage wiring requirements.
   2. Separation of power and low voltage/data wiring.
   3. Wire labeling.
   4. Lighting management hub locations and installation.
   5. Control locations.
   6. Computer jack locations.
   7. Load circuit wiring.
   8. Network wiring requirements.

9. Connections to other equipment and other Lutron equipment.
10. Installer responsibilities.
11. Power panel locations.

C. Sequencing:
1. Do not install sensors and wall controls until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
1. Occupancy/Vacancy Sensors: Include detailed basic motion detection coverage range diagrams.

C. Shop Drawings:
1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
2. Provide detailed sequence of operations describing system functions.

D. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by Product Testing Agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Title 24 Acceptance Testing Documentation: Submit Certification of Acceptance and associated documentation for lighting control acceptance testing performed in accordance with CAL TITLE 24 P6, as specified in Part 3 under "COMMISSIONING".

F. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

G. Warranty: Submit Sample of Manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final execution completed in Owner's name and registered with Manufacturer.

1.6 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the Project Site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications:
1. Company with not less than 10-years of experience manufacturing lighting control systems of similar complexity to specified system.
2. Registered to ISO 9001, including in-house engineering for product design activities.
3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

D. Title 24 Acceptance Testing Technician Qualifications: Certified by a California approved Acceptance Test Technician Certification Provider (ATTCP) as an Acceptance Test Technicians (ATTs) in accordance with CAL TITLE 24 P6.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original Manufacturer's packaging in accordance with Manufacturer's written instructions until ready for installation.

1.8 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional Warranty requirements.

B. Manufacturer's Standard Warranty, with Manufacturer Start-Up; Lutron Standard 2-year Warranty; Lutron LSC-B2:
   1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:
      a. First Two Years:
         1) 100 percent replacement parts coverage, 100 percent Manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
         2) First-available on-site or remote response time.
         3) Remote diagnostics for applicable systems.
      b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding Manufacturer holidays.
   2. Lighting Management System Computer: One year 100 percent parts coverage, 1-year 100 percent Manufacturer labor coverage.
   3. Ballasts/Drivers and Ballast Modules: 5-years 100 percent parts coverage, no Manufacturer labor coverage.

C. Include as part of the base bid additional costs for Manufacturer's Enhanced Warranty with Manufacturer Start-up; Silver Enhanced Warranty; Lutron LSC-E8S; coverage to include items listed under Manufacturer's standard warranty with Manufacturer start-up above, plus the following upgrades:
   1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:
      a. First Two Years:
         1) As-available Field Service response; no committed response time.
      b. Additional Coverage for year’s 3-5: 50 percent replacement parts coverage, no Manufacturer labor coverage.
      c. Additional Coverage for year’s 6-8: 25 percent replacement parts coverage, no Manufacturer labor coverage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Lutron Electronics Company, Inc.; www.lutron.com.

B. Substitutions: See Section 016000 - Product Requirements.
   1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by Architect a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the Specification noting compliance on a line-by-line basis.
   2. By using pre-approved substitutions, Contractor accepts responsibility and associated costs for all required modifications to related equipment and wiring. Provide complete Engineered Shop Drawings (including power wiring) with deviations from the original design highlighted in an alternate color for review and approval by Architect prior to rough-in.

2.2 DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

A. Sensor Layout and Tuning: No Lighting Control Manufacturer Sensor Layout and Tuning service to be provided; Lutron LSC-NO-SENS-LT.
   1. Contractor to utilize Lighting Control Manufacturer Installation Instructions to place/install sensors.
   2. At Pre-wire and Startup, Lighting Control Manufacturer to provide a rough sensor calibration only. Sensor fine-tuning to be the responsibility of Contractor.

B. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

C. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.

D. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.

E. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

F. Dimming and Switching (Relay) Equipment:
   1. Designed so that electrolytic capacitors operate at least 36 degrees F (20 degrees C) below the capacitor's maximum temperature rating when the device is under fully loaded conditions at maximum rated temperature.
   2. Inrush Tolerance:
      a. Utilize load-handling thyristors (SCRs and triacs), field effect transistors (FETs) and isolated gate bipolar transistors (IGBTs) with maximum current rating at least two times the rated operating current of the dimmer/relay.
      b. Capable of withstanding repetitive inrush current of 50 times the operating current without impacting lifetime of the dimmer/relay.
   3. Surge Tolerance:
      a. Panels: Designed and tested to withstand surges of 6,000 V, 3,000 amps according to IEEE C62.41.2 and IEC 61000-4-5 without impairment to performance.
      b. Other Power Handling Devices: Designed and tested to withstand surges of 6,000 V, 200 amps according to IEEE C62.41.2 without impairment to performance.
   4. Power Failure Recovery: When power is interrupted and subsequently restored, within 3 seconds lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.
   5. Dimming Requirements:
      a. Line Noise Tolerance: Provide real-time cycle-by-cycle compensation for incoming line voltage variations including changes in RMS voltage (plus or minus 2 percent change in RMS voltage per cycle), frequency shifts (plus or minus 2Hz change in frequency per second), dynamic harmonics, and line noise.
         1) Systems not providing integral cycle-by-cycle compensation to include external power conditioning equipment as part of dimming system.
      b. Incorporate electronic "soft-start" default at initial turn-on that smoothly ramps lights up to the appropriate levels within 0.5 seconds.
      c. Utilize air gap off to disconnect the load from line supply.
      d. Control all light sources in smooth and continuous manner. Dimmers with visible steps are not acceptable.
      e. Load Types:
         1) Assign a load type to each dimmer that will provide a proper dimming curve for the specific light source to be controlled.
         2) Provide capability of being field-configured to have load types assigned per circuit.
      f. Minimum and Maximum Light Levels: User adjustable on a circuit-by-circuit basis.
      g. Line Voltage Dimmers:
         1) Dimmers for Magnetic Low Voltage (MLV) Transformers:
            a) Provide circuitry designed to control and provide a symmetrical AC waveform to input of magnetic low voltage transformers per UL 1472.
            b) Dimmers using unipolar load current devices (such as FETs or SCRs) to include DC current protection in the event of a single device failure.
         2) Dimmers for Electronic Low Voltage (ELV) Transformers: Operate transformers via reverse phase control. Alternately, forward phase control dimming may be used if Dimming Equipment Manufacturer has recommended specific ELV transformers being provided.

3) Dimmers for Neon and Cold Cathode Transformers:
   a) Magnetic Transformers: Listed for use with normal (low) power factor magnetic transformers.
   b) Electronic Transformers: Must be supported by the Ballast Equipment Manufacturer for control of specific ballasts being provided.

h. Low Voltage Dimming Modules:
   1) Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to a single zone.
   2) Single low voltage dimming module; capable of controlling the following light sources:
      a) 0-10V analog voltage signal.
         - Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
         - Sink current according to IEC 60929.
         - Source current.
      b) 10-0V reverse analog voltage signal.
      c) DSI digital communication.
      d) DALI broadcast communication per IEC 60929:
         - Logarithmic intensity values complying with IEC 60929.
         - Linear intensity values for use with LED color intensity control.
      e) PWM per IEC 60929.

6. Switching Requirements:
   a. Rated Life of Relays: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
   b. Switch load in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
   c. Provide output fully rated for continuous duty for inductive, capacitive, and resistive loads.

G. Device Finishes:
   1. Standard Colors: Comply with NEMA WD1 where applicable.
   2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units.
   3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

2.3 POWER PANELS

A. Provide power panels with configurations as indicated on the Drawings.

B. General Requirements:
   1. Listed to UL 508 as industrial control equipment.
   2. Comply with UL 508A and IEC 60669-2-1 as applicable.
   3. Delivered and installed as a listed factory-assembled panel.
   4. Field wiring accessible from front of panel without removing dimmer assemblies or other components.
   5. Passively cooled via free-convection, unaided by fans or other means.
   6. Shipped with each dimmer in mechanical bypass position by means of jumper bar inserted between input and load terminals. Jumpers to carry full rated load current and be reusable at any time. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.
   7. Provided with branch circuit protection for each input circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the Drawings.
   8. Branch Circuit Breakers:
      a. Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
      b. Provided with visual trip indicator.
      c. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      d. Thermal-magnetic construction for overload, short-circuit, and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
      e. Equipped with provision for tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.

f. Replaceable without moving or replacing dimmer/relay assemblies or other panel components.
g. Listed as Switch Duty (SWD) so that loads can be switched on and off by breakers.

9. Provide panels with listed short circuit current rating not less than the available fault current at the installed location as indicated on the Drawings.
10. Panel Processor; Lutron Circuit Selector:
    a. Provide the following capabilities:
        1) Operate circuit directly from panel processor for system diagnostics and provide feedback of system operation.
        2) Electronically assign each circuit to any zone in lighting control system.
        3) Determine normal/emergency function of panel and set emergency lighting levels.
    b. React to changes from control within 20 milliseconds.
11. Diagnostics and Service:
    a. Replacing dimmer/relay does not require re-programming of system or processor.
    b. Include diagnostic LEDs for dimmers/relays to verify proper operation and assist in system troubleshooting.
    c. Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
        1) If lighting control system fails, lights to remain at current level. Panel processor provides local control of lights until system is repaired.
        2) If panel processor fails, lights to remain at current level. Circuit breakers can be used to turn lights off or to full light output, allowing non-dim control of lights until panel processor is repaired.
        3) If dimmer fails, factory-installed mechanical bypass jumpers to allow each dimmer to be mechanically bypassed. Mechanical bypass device to allow for switching operation of connected load with dimmer removed by means of circuit breaker.

C. Product(s):
1. Relay Panels:
    a. Product: Lutron XP Series Switching Panels.
    b. Provide surface-mounted or flush-mounted enclosures as indicated.
    c. Switching Requirements:
        1) Utilize 20 A continuous-use rated switching modules; able to switch 20 A receptacles.
        2) Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
        3) Switch load in a manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
        4) Provide output fully rated for continuous duty for inductive, capacitive, and resistive loads.

2.4 LED DRIVERS

A. General Requirements:
1. Operate for at least 50,000 hours at maximum case temperature and 90 percent non-condensing relative humidity.
2. Provide thermal fold-back protection by automatically reducing power output (dimming) to protect LED driver and LED light engine/fixture from damage due to over-temperature conditions that approach or exceed the LED driver's maximum operating temperature at calibration point.
3. Provide integral recording of operating hours and maximum operating temperature to aid in troubleshooting and warranty claims.
4. Designed and tested to withstand electrostatic discharges incurred during manufacturing, installation, or field troubleshooting without impairment of performance when tested according to IEC 61000-4-2.
5. Manufactured in a facility that employs ESD reduction practices in compliance with ANSI/ESD S20.20.
6. UL 8750 recognized or listed as applicable.
7. UL Type TL rated where possible to allow for easier fixture evaluation and listing of different driver series.
8. UL 1598C listed for field replacement as applicable.

9. Designed and tested to withstand Category A surges of 4,000 V according to IEEE C62.41.2 without impairment of performance.
10. Class A sound rating; inaudible in a 27 dBA ambient.
11. Demonstrate no visible change in light output with a variation of plus or minus 10% change in line-voltage input.
12. LED drivers of the same family/series to track evenly across multiple fixtures at all light levels.
13. Offer programmable output currents in 10 mA increments within designed driver operating ranges for custom fixture length and lumen output configurations, while meeting a low-end dimming range of 100% to 1% or 100% to 5% as applicable.
14. Meet NEMA 410 inrush requirements.
15. Employ integral fault protection up to 277 V to prevent LED driver damage or failure in the event of incorrect application of line-voltage to communication link inputs.
16. LED driver may be remote located up to 100 feet (30 m) from LED light engine depending on power outputs required and wire gauge utilized by installer.

B. Digital Control (when used with compatible Lutron lighting control systems):
   1. Employ power failure memory; LED driver to automatically return to the previous state/light level upon restoration of utility power.
   2. Operate from input voltage of 120 V through 277 V at 50/60Hz.
   3. Automatically go to 100% light output upon loss of control link voltage and lock out system commands until digital control link voltage is restored. Manufacturer to offer UL 924 compliance achievable through use of external Lutron Model LUT-ELI-3PSH interface upon request.
   4. Each driver responds independently per system maximum:
      a. Up to 32 occupant sensors.
      b. Up to 16 daylight sensors.
   5. Responds to digital load shed command. (Example: If light output is at 30% and a load shed command of 10% is received, the ballast automatically sets the maximum light output at 90% and lowers current light output by 3% to 27%).
   6. Digital low-voltage control wiring capable of being wired as either Class 1 or Class 2.

C. Product(s):
   1. Digital Control, Five Percent Dimming; Lutron 5-Series (LDE5-Series):
      a. Dimming Range: 100% to 5% measured output current.
      b. Typically dissipates 0.2 W standby power at 120 V and 0.3 W standby power at 277 V.
      c. Complies with FCC requirements of CFR, Title 47, Part 15, for commercial applications at 120-277 V.
      d. Constant Current Reduction (CCR) dimming method.
      e. Total Harmonic Distortion (THD): Less than 21% at full load; complies with ANSI C82.11.
      f. Constant Current Drivers:
         1) Support for downlights and pendant fixtures in select currents from 350 mA to 1.4 A to ensure a compatible driver exists.
            a) Support LED arrays up to 35 W.
            b) Models available that meet requirements for Energy Star compliance.
         2) Support for troffers, linear pendants, and linear recessed fixtures from 150 mA to 2.1 A to ensure a compatible driver exists.
            a) Support LED arrays up to 75 W.
            b) Models available to meet the Design Lights Consortium (DLC) power line quality requirements.
   2. Digital Control, 1% Dimming with Soft-On and Fade-to-Black Low End Performance; Lutron Hi-lume 1% Soft-on Fade-to-Black (LDE1-Series):
      a. Dimming Range: 100% to 1% measured output current.
      b. Features smooth fade-to-on and fade-to-black (Lutron Soft-On, Fade-to-Black) low end dimming performance for an incandescent-like dimming experience.
      c. Typically dissipates 0.2 W standby power at 120 V and 0.3 W standby power at 277 V.
      d. Complies with FCC requirements of CFR, Title 47, Part 15, for commercial applications at 120-277 V.
      e. Employs true Constant Current Reduction (CCR) dimming method from 100 to five percent light level and Pulse Width Modulation (PWM) dimming method from five percent to off.

f. Pulse Width Modulation (PWM) frequency of 240 Hz.
g. Total Harmonic Distortion (THD): Less than 20% at full output for drivers greater than 25 W; complies with ANSI C82.11.
h. UL Class 2 output.
i. Driver outputs to be short circuit protected, open circuit protected, and overload protected.
j. Constant Current Driver; Lutron K-Case Form Factor: Support for fixtures from 220 mA to 1.4 A over multiple operating ranges.
   1) Support LED arrays up to 40 W.
   2) Models available that meet requirements for Energy Star compliance.
k. Constant Current Driver; Lutron M-Case Form Factor: Support for fixtures from 150 mA to 2.1 A over multiple operating ranges.
   1) Support LED arrays up to 75 W.
   2) Models available to meet the Design Lights Consortium (DLC) power line quality requirements.

2.5 LIGHTING CONTROL MODULES (LUTRON ENERGY SAVER NODE)

A. Provide lighting control modules as indicated or as required to control the loads as indicated.

B. General Requirements:
1. Listed to UL 508 as industrial control equipment.
2. Delivered and installed as a listed factory-assembled panel.
3. Passively cooled via free-convection, unaided by fans or other means.
4. Mounting: Surface.
5. Connection without interface to wired:
   a. Occupancy sensors.
   b. Daylight sensors.
   c. IR receivers for personal control.
6. Connects to lighting management hub via RS485.
7. LED status indicators confirm communication with occupancy sensors, daylight sensors, and IR receivers.
8. Contact Closure Input:
   a. Directly accept contact closure input from a dry contact closure or sold-state output without interface to:
      1) Activate scenes.
         a) Scene activation from momentary or maintained closure.
      2) Enable or disable after hours.
         a) Automatic sweep to user-specified level after user-specified time has elapsed.
         b) System will provide occupants a visual warning prior to sweeping lights to user-specified level.
         c) Occupant can reset timeout by interacting with the lighting system.
      3) Activate or deactivate demand response (load shed).
         a) Load shed event will reduce lighting load by user-specified amount.
9. Emergency Contact Closure Input:
   a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 listed emergency lighting interface, security system or fire alarm system.
   b. Allow configurable zone response during emergency state.
   c. Disable control operation until emergency signal is cleared.
10. Supplies power for control link for keypads and control interfaces.
11. Distributes sensor data among multiple lighting control modules.
12. Capable of being controlled via wireless sensors and controls.

C. 0-10V Lighting Control Modules:
1. Product(s):
2. Coordination Between Low Voltage Dimming Module and Line Voltage Relay: Capable of being electronically linked to single zone.
3. Single low voltage dimming module; capable of controlling following light sources:
   a. 0-10V analog voltage signal.
      1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.

2) Sink current per IEC 60929.
b. 10V-0V analog voltage signal.
1) Provide Class 2 isolated 0-10V output signal conforming to IEC 60929.
2) Sink current per IEC 60929.
4. Switching:
a. Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.
b. Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.
c. Fully rated output continuous duty for inductive, capacitive, and resistive loads.
d. Module to integrate up to four individually controlled zones.
e. Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.

D. Digital Fixture Lighting Control Modules:
1. Product(s):
a. Lutron EcoSystem Energi Savr Node; Model QSN-1ECO-S: One EcoSystem Digital Link.
b. Lutron EcoSystem Energi Savr Node; Model QSN-2ECO-S: Two EcoSystem Digital Links.
2. Provides two-way feedback with digital fixtures for energy monitoring, light level status, lamp failure reporting, and ballast/driver failure reporting.
3. Provide testing capability using manual override buttons.
4. Each low-voltage digital communication link to support up to 64 ballasts or LED drivers capable of NFPA 70 Class 1 or Class 2 installation.

2.6 LIGHTING MANAGEMENT HUBS

A. Product: Lutron Quantum Light Management Hub.

B. Provided in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.

C. Connects to controls and power panels via RS485.

D. Enables light management software to control and monitor compatible dimming ballasts and ballast modules, power panels, power modules, and window treatments.
1. Utilizes Ethernet connectivity to light management computer utilizing one of the following methods:
a. Dedicated network.
b. Dedicated VLAN.
c. Shared network with Building Management System (BMS).
d. Corporate network where managed switches are configured to allow multicasting and use of IGMP.

E. Integrates control station devices, power panels, shades, preset lighting controls, and external inputs into a single customizable lighting control system with:
1. Multiple Failsafe Mechanisms:
a. Power failure detection via emergency lighting interface.
b. Protection: Lights go to full on if ballast wires are shorted.
c. Distributed architecture provides fault containment. Single hub failure or loss of power does not compromise lights and shades connected to other lighting management hubs.
2. Manual overrides.
3. Automatic control.
4. Central computer control and monitoring.
5. Integration with BMS via BACnet.

F. Furnished with astronomical time clock.

G. Maintains a backup of the programming in a non-volatile memory capable of lasting more than 10-years without power.

H. BACnet Integration License:
   1. Provide ability to communicate by means of native BACnet IP communication (does not require interface) to lighting control system from a user-supplied 10BASE-T or 100BASE-T Ethernet network.
   2. Requires only one network connection per system.
   3. Lighting control system to be BACnet Test Laboratory (BTL) listed.
   4. Basic BACnet integration license:
      a. The BACnet integrator can command:
         1) Area light output.
         2) Area enable or disable after hours mode.
         3) Area load shed level.
         4) Area load shed enable/disable.
         5) Enable/Disable:
            a) Area occupancy sensors.
            b) Area daylighting.
         6) Daylighting level.
         7) Area occupied and unoccupied level
         8) Occupancy sensor timeouts.
      b. The BACnet integrator can monitor:
         1) Area on/off status.
         2) Area occupancy status.
         3) Area fault.
            a) Lamp failures.
            b) Control devices not responding.
         4) Area load shed status.
         5) Area instantaneous energy usage and maximum potential power usage.
         6) Energy savings broken out by strategy (occupancy, timeclock, daylighting, personal control, tuning, load shed) down to the individual area.
         7) Enable/Disable:
            a) Area occupancy sensors.
            b) Daylighting.
            c) Timeclocks.
         8) Daylighting level.
         9) Light levels from photo sensors or Radio Window sensors.
         10) Area occupied and unoccupied level.
         11) Occupancy sensor timeouts.
   5. Integration with other devices over Ethernet via Telnet using the Lutron Integration Protocol.
   6. Control other devices over Ethernet via TCP or Telnet by sending device specific strings.

2.7 LIGHTING MANAGEMENT SYSTEM COMPUTERS

A. Computers:
   1. Product: Lutron Q-Manager.
   2. System PC (Desktop/Laptop):
      a. Suitable for occasional programming, monitoring, and control of digital network lighting controls.
      b. Unless otherwise indicated, computer(s) to be provided by others, meeting Lighting Control System Manufacturer's minimum requirements.
      c. Minimum Hardware Requirements:
         1) Processor: Single Intel® Core® i3 processor with minimum speed of 2.4 GHz.
         2) 4 GB RAM.
         3) 250 GB hard drive (40 GB for application).
         4) One 10/100/1000 Ethernet network interface for communication with lighting management hubs.
         5) Monitor with 1280 x 1024 resolution.
         6) 4 USB 2.0 ports.
         7) Dedicated Graphics Card with 256 MB of memory.

d. Minimum Software Requirements:
    1) Licensed installation of US English 64-bit Microsoft® Windows® 7 Professional with Service Pack 1, US English 64-bit Microsoft® Windows® 8 Professional, or US English 64-bit Microsoft® Windows® 8.1 Professional.
    2) Microsoft® Internet Information Services (IIS) 7 or later.
    3) Microsoft® Internet Explorer 9 or later.
    4) Microsoft®.NET Framework 3.5.
    5) Microsoft®.NET Framework 4.5.

3. Server:
    a. Suitable for 24 hour per day, 7 day per week programming, monitoring, control, and data logging of digital-network lighting controls.
    b. Suitable to handle client machine request in multi-computer systems.
    c. Unless otherwise indicated, computer to be provided by others, meeting Lighting Control System Manufacturer's minimum requirements.
    d. Minimum Hardware Requirements:
        1) Processor: Quad Core Intel® Xeon® processor.
        2) 8 GB Ram.
        3) 250 GB hard drive (40 GB for application and database).
        4) Two 10/100/1000 Ethernet network interfaces - one for communication with lighting management hubs and one for communication with corporate intranet to allow access from system PCs and/or energy saving display terminals. Only one Ethernet Network Interface is required if all lighting management hubs and client PCs are on the same network.
        5) Monitor with 1280 x 1024 resolution.
        6) 4 USB 2.0 ports.
        7) Dedicated Graphics Card with 256 MB of memory (only required if running client software from the server).
    e. Minimum Software Requirements:
        1) Licensed installation of US English 64-bit Microsoft® Windows® Server 2008 R2, Windows Server 2012 R1, or Windows Server 2012 R2.
        2) Microsoft® Internet Information Services (IIS) 7 or later.
        3) Microsoft® Internet Explorer 9 or later.
        4) Microsoft®.NET Framework 3.5.
        5) Microsoft®.NET Framework 4.5.

2.8 LIGHTING MANAGEMENT SYSTEM SOFTWARE

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

B. Configuration Setup Software:
    1. Product: Lutron Q-Design.
    2. Suitable to make system programming and configuration changes using a Graphical Floor Plan view or a generic system layout.
    3. Windows-based, capable of running on either central server or a remote client over TCP/IP connection.
    4. Publish Graphical Floor Plan: Allows the user to publish new Graphical Floor Plan files, allowing users to monitor the status of lights, occupancy of areas, and daylighting status.
    5. Back-Up Project Database: Allows the user to back up the Project database that holds all the configuration information for the system, including keypad programming, area scenes, daylighting, occupancy programming, emergency levels, night lights, and time clock.
    6. Publish Project Database: Allows the user to send a new Project database to the server and download the new configuration to the system. The Project database holds all the configuration information for the system, including keypad programming, area scenes, daylighting, occupancy programming, emergency levels, night lights, and time clock.
    7. Allows Manufacturer (either remotely or with on-site service call) or end-user (with training) to:
        a. Capture system design:
            1) Geographical layout.
            2) Load schedule zoning.

3) Equipment schedule.
4) Equipment assignment to lighting management hubs.
5) Daylighting design.

b. Define the configuration for the following in each area:
1) Lighting scenes.
2) Control station devices.
3) Interface and integration equipment.
4) Occupancy/after hours.
5) Partitioning.
6) Daylighting.
7) Emergency lighting.
8) Night lights.

c. Startup:
1) Addressing.
2) Daylighting.
3) Provide customized conditional programming.

C. Control and Monitor Software:

1. Product: Lutron Quantum Vue.
2. General Requirements:
a. Web-based; runs on most HTML5 compatible browsers (including Internet Explorer, Chrome, and Safari).
b. Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone; optimized for displays of 1024 by 768 pixels or higher.
c. User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
d. Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
e. All functionality listed below must be available via a single application.
3. System Navigation and Status Reporting:
a. Performed using Graphical Floor Plan view or a generic system layout.
b. Graphical Floor Plan View: Utilizes customized CAD Based Drawing of the building. Pan and zoom feature allows for easy navigation; dynamically adjusts the details presented based on zoom level.
c. Area, scene, and zone names can be changed in real time.
d. Adjustments can be made based on area type.
4. Control of Lights:
a. Control and monitor individual lights from a graphical floor plan (with Lutron EcoSystem digital ballasts/drivers).
1) Individual lights can be monitored for on/off status.
2) Individual lights can be turned on/off or sent to a specific level.
3) High end of individual lights can be tuned/trimmed.
b. Control and monitor zone/area lights.
1) Area lights can be monitored for on/off status.
2) All lights in an area can be turned on/off or sent to a specific level.
3) For areas that have been zoned, these areas may be sent to a predefined lighting scene, and individual zones may be controlled.
4) Area lighting scenes can be renamed and modified in real-time, changing the levels that zones go to when a scene is activated.
5) High and low end of area lighting can be tuned/trimmed.
c. Control and monitor area partition status from a Graphical Floor Plan.
5. Occupancy:
a. Area occupancy can be monitored.
b. Area occupancy can be disabled to override occupancy control or in case of occupancy sensor problems.
c. Area occupancy settings including level that lights turn on to when area is occupied, and level that lights turn off to when area is unoccupied can be changed in real-time.
d. Monitor energy savings due to occupancy down to an individual area.

6. Daylighting:
    a. Daylighting can be enabled/disabled. Can be used to override the control currently taking place in the space.
    b. Daylight calibration can be adjusted for each daylit area.
    c. Daylight status can be monitored.
    d. Monitor energy savings due to daylight harvesting down to an individual area.
7. Load Shedding; Lutron IntelliDemand: Allows the building manager to monitor whole building lighting power usage and apply a customized load shed reduction to selected areas, thereby reducing a building's power usage; load shedding triggered via Quantum Vue software or BACnet.
8. Scheduling: Schedule time of day and astronomic time clock events to automate functions.
    a. Adjust or disable a single occurrence of a repeating scheduled event.
    b. Easily monitor and adjust scheduled events using a weekly calendar view.
9. Reporting: Provide reporting capability that allows the building manager to gather real-time and historical information about the system as follows:
    a. Energy Reports: Show a comparison of cumulative energy used over a period of time for one or more areas.
    b. Power Reports: Show power usage trend over a period of time for one or more areas.
    c. Energy Density Report: Show energy usage in W/sq ft.
    d. Energy Savings by Strategy Report: Show energy savings for any area broken down by strategy (tuning, occupancy, daylighting, scheduled events, personal control, and load shedding).
    e. Space Utilization/Occupancy Reports: Show historical occupancy over a period of time for one or more areas using a graphical floor plan, generic system layout, and/or graphs and charts.
    f. Activity Report: Show what activity has taken place over a period of time for one or more areas. Activity includes occupant activities (e.g. wall controls being pressed), building manager operation (e.g. controlling/changing areas using the control and monitor tool), and device failures (e.g. keypads or ballasts that are not responding).
    g. Lamp Failure Report: Shows which areas are currently reporting lamp failures.
    h. Sensor Level Report: Shows the light level in footcandles of any photo sensor in the system.
    i. Alert Activity Report: Capable of generating historical reports of all alert activity within the system.
10. Diagnostics: Allows the building manager to check on the status of all equipment in the lighting control system. Devices to be listed with a reporting status of OK, missing, or unknown.
11. Alerts and Alarms: Monitors the system for designated events/triggers and automatically generates alerts according to configured response criteria.
    a. Capable of monitoring for the following events/triggers:
        1) A failed piece of equipment (e.g. ballast, control, sensor, etc.); alert cleared when equipment is replaced.
        2) A lamp outage (for compatible EcoSystem digital electronic dimming ballasts only); alert cleared when lamp is replaced.
        3) Low battery conditions in battery-operated sensors and controls; alert cleared when battery is replaced.
        4) Luminaires with lamp operating hours in excess of designated time.
        5) A load shed event; alert generated for beginning and end of trigger.
        6) Energy usage higher than designated threshold target.
        7) Potential light level condition discrepancies (daylight sensors not agreeing with expected lighting status).
        8) Potential sensor failures (Radio Window sensors that have not seen a change in light level).
    b. View alerts on a customized graphical floor plan.
    c. Capable of generating alerts through visible changes in software or through email messages.
    d. Capable of customizing the frequency of alerts and providing notifications immediately or through daily, weekly, or monthly summaries.
    e. Capable of sending different alerts to different system users.
    f. Capable of generating historical reports of all alert activity within the system.

12. Administration:
    a. Users: Allows new user accounts to be created and existing user accounts to be edited.
        1) Supports Active Directory (LDAP) tying user accounts to network accounts.
    b. Area and feature access can be restricted based on login credentials with assigned levels of access rights (Monitor, Control Only, Control and Edit, Admin) and customized access levels available.
13. Quick Controls: Create shortcuts to activate customized system-wide actions, such as updating lighting and/or shade levels.
14. Provides control/monitoring of partition status to automatically reconfigure how the space operates based on the partition's open/closed status.
15. Variables: Used for custom program of a system and/or to signal a third party system. Any change may cause a change in the behavior of the system.
    a. View the current state of system variables across subsystems.
    b. Update the current variable state across all subsystems.
16. Device Lock/Unlock: Allows the building manager to lock control station devices to prevent building occupants from activating their programming (button presses), until they are unlocked.
    a. Keypads can be locked to help ensure occupants cannot change light and shade levels in a public space during specific events or business hours.
    b. Keypads can be unlocked after events/during afterhours to allow maintenance, cleaning, security, and others to perform their tasks without needing to contact a Building Manager.

D. Contractor shall provide factory commissioning to support prefunctional and functional testing with CxA witnessing. See General Commissioning Requirements Section 019113.

2.9 CONTROL STATIONS

A. Provide control stations with configuration as indicated or as required to control the loads as indicated.

B. Wired Control Stations:
    1. General Requirements:
        a. Power: Class 2 (low voltage).
        b. UL listed.
        c. Provide faceplates with concealed mounting hardware.
        d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
        e. Finish: As specified for wall controls in "Device Finishes" under DIGITAL NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS article above.
    2. Multi-Scene Wired Control:
        a. General Requirements:
            1) Allows control of any devices part of the lighting control system.
            2) Allows for easy reprogramming without replacing unit.
            3) Replacement of units does not require reprogramming.
            4) Communications: Utilize RS485 wiring for low-voltage communications link.
            5) Engrave keypads with button, zone, and scene descriptions as indicated on the Drawings.
            6) Software Configuration:
                a) Customizable control station device button functionality:
                - Buttons can be programmed to perform single defined action.
                - Buttons can be programmed to perform defined action on press and defined action on release.
                - Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
                - Buttons can be programmed to perform automatic sequence of defined actions.
                - Capable of deactivating select keypads to prevent accidental changes to light levels.
                - Buttons can be programmed for raise/lower of defined loads.

- Buttons can be programmed to toggle defined set of loads on/off.

7) Status LEDs:
   a) Upon button press, LEDs to immediately illuminate.
   b) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
   c) Support logic that defines when LED is illuminated:
      - Scene logic (logic is true when all zones are at defined levels).
      - Room logic (logic is true when at least one zone is on).
      - Pathway logic (logic is true when at least one zone is on).
      - Last scene (logic is true when spaces are in defined scenes).

b. Wired Keypads; Lutron see Touch QS Wallstations:
   1) Style: Architectural Non-Insert Style.
   2) Mounting: Wallbox or low-voltage mounting bracket; provide wall plates with concealed mounting hardware.
   3) Button/Engraving Backlighting:
      a) Utilize backlighting for buttons and associated engraving to provide readability under all light conditions.
      b) Backlight intensity adjustable via programming software.
   4) Design keypads to allow field-customization of button color, configuration, and engraving using field-changeable replacement kits.
   5) Contact Closure Interface: Provide two contact closure inputs on back of unit which provide independent functions from front buttons; accepts both momentary and maintained contact closures.
   6) Terminal block inputs to be over-voltage and miswire-protected against reversals and shorts.

c. Wired Keypads; Lutron QS Wired Palladiom Wallstations:
   1) Style: Architectural Style.
   2) Mounting: Wallbox; provide wall plates with concealed mounting hardware.
   3) Buttons and Faceplate:
      a) Buttons to be greater than 0.65 inch (16.5 mm) in height to provide large target area for ease of use and actuation.
      b) Front of buttons to be flush with faceplate.
      c) Buttons and faceplate to be of the same material and finish (e.g. plastic/plastic, glass/glass, metal/metal).
      d) Buttons to depress and provide tactile feedback of a successful button push. Controls utilizing capacitive or resistive touch technology are not acceptable.
      e) Gaps to be less than 0.007 inch (0.18 mm) between buttons and less than 0.15 inch (3.8 mm) between buttons and faceplate.
   4) Button/Engraving Backlighting:
      a) Backlighting to be visible through engraved text to provide clear readability in a variety of lighting conditions.
      b) Indicate active scene through the intensity of the backlighting (brighter backlit text indicates the active state).
      c) Backlight intensity adjustable via programming software; capable of dynamic adjustment during usage based on conditional logic (time of day, button press, etc.).
      d) Backlight intensity automatically adjusts based on room ambient light level.
   5) Keypads to allow field-customization of button color and engraving using field-changeable replacement kits.
   6) Terminal block inputs to be over-voltage and miswire-protected against reversals and shorts.

C. Wireless (Radio Frequency) Controls:
   1. Product(s):
      a. Type _____ - 4-Button; Lutron Pico Wireless Control Model PJ2-4B.
         1) Button Marking: Scene keypads (light).
   2. Quantity: As indicated on the Drawings.
   3. Communicates via radio frequency to compatible dimmers, switches, and plug-in modules.

4. Does not require external power packs, power or communication wiring.
5. Allows for easy reprogramming without replacing unit.
6. Button Programming:
   a. Single action.
   b. Toggle action.
   c. Defined action on press and defined action on release.
7. Includes LED to indicate button press or programming mode status.
8. Mounting:
   a. Capable of being mounted with a table stand or directly to a wall under a faceplate.
   b. Faceplates: Provide concealed mounting hardware.
9. Power: Battery-operated with minimum ten-year battery life.
10. Finish: As specified for wall controls in "Device Finishes" under DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS article above.

2.10 LOW-VOLTAGE CONTROL INTERFACES

A. Provide low-voltage control interfaces as indicated or as required to control the loads as indicated.

B. UL listed.

C. Sensor Modules:
   1. Products:
      a. Sensor module with both wired and wireless inputs; Lutron Model QSM2-4W-C.
   2. Wired Modules:
      a. Provide wired inputs for:
         1) Occupancy sensors.
         2) Daylight sensors.
         3) IR receivers for personal control.
         4) Digital ballast wall stations.
   3. Wireless Modules:
      a. Provide wireless communication inputs for:
         1) Occupancy sensors.
         2) Daylight sensors.
         3) Wireless controller.
      b. RF Range: 30 feet (9 m) between sensor and compatible RF receiving devices.
      c. RF Frequency: 434 MHz; operates in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
   4. Communicate sensor information to wired low-voltage digital link for use by compatible devices.

2.11 WIRED SENSORS

A. Wired Occupancy Sensors:
   1. General Requirements:
      a. Connects directly to compatible ballasts and modules without the need of a power pack or other interface.
      b. Turns off or reduces lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space.
      c. Accommodates all conditions of space utilization and all irregular work hours and habits.
      d. Comply with UL 94.
      e. Self-Adaptive Sensors: Continually adjusts sensitivity and timing to ensure optimal lighting control for any use of the space; furnished with field-adjustable controls for time delay and sensitivity to override any adaptive features.
      f. Provide capability to:
         1) Add additional timeout system-wide without need to make local adjustment on sensor.
         2) Group multiple sensors.
      g. Power Failure Memory: Settings and learned parameters to be saved in non-volatile memory and not lost should power be interrupted and subsequently restored.
      h. Furnished with all necessary mounting hardware and instructions.
      i. Class 2 devices.

j. Color: White.
2. Wired Dual Technology Sensors:
   a. Passive Infrared: Utilize multiple segmented lenses, with internal grooves to eliminate dust and residue build-up.
   b. Ultrasonic: Utilize an operating frequency of 32 kHz or 40 kHz, crystal-controlled to operate within plus/minus 0.005 percent tolerance.

2.12 WIRELESS SENSORS

A. General Requirements:
   1. Operational life of 10 years without the need to replace batteries when installed per Manufacturer's instructions.
   2. Communicates directly to compatible RF receiving devices through use of a radio frequency communications link.
   3. Does not require external power packs, power wiring, or communication wiring.
   4. Capable of being placed in test mode to verify correct operation from the face of the unit.
   5. RF Range: 30 feet (9 m) between sensor and compatible RF receiving device(s).
   6. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.

B. Wireless Occupancy/Vacancy Sensors:
   1. General Requirements:
      a. Provides a clearly visible method of indication to verify that motion is being detected during testing and that the unit is communicating to compatible RF receiving devices.
      b. Utilize multiple segmented lenses, with internal grooves to eliminate dust and residue build-up.
      c. Sensing Mechanism: Passive infrared coupled with technology for sensing fine motions; Lutron XCT Technology. Signal processing technology detects fine-motion passive infrared (PIR) signals without the need to change the sensor's sensitivity threshold.
      d. Provide optional, readily accessible, user-adjustable controls for timeout, automatic/ manual-on, and sensitivity.
      e. Turns off lighting after reasonable and adjustable time delay once the last person to occupy the space vacates a room or area. Provide adjustable timeout settings of 1, 5, 15, and 30 minutes.
      f. Capable of turning dimmer's lighting load on to an optional locked preset level selectable by the user. Locked preset range to be selectable on the dimmer from 1 percent to 100 percent.
      g. Color: White.
      h. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
      i. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
      j. Sensor lens to illuminate during test mode when motion is detected to allow installer to verify coverage prior to permanent mounting.
      k. Ceiling-Mounted Sensors:
         1) Provide customizable mask to block off unwanted viewing areas.
   2. Wireless Combination Occupancy/Vacancy Sensors:
      a. Ceiling-Mounted Sensors: Programmable to operate as an occupancy sensor (automatic-on and automatic-off), an occupancy sensor with low light feature (automatic-on when less than one footcandle of ambient light available and automatic-off), or a vacancy sensor (manual-on and automatic-off).

C. Wireless Daylight Sensors:
   1. Product: Lutron Model LFR2-DCRB.
   2. Open-loop basis for daylight sensor control scheme.
   3. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).

4. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
5. Provide linear response from 0 to 10,000 footcandles.
6. Color: White.
7. Mounting:
   a. Provide surface mounting bracket compatible with drywall, plaster, wood, concrete, and compressed fiber ceilings.
   b. Provide all necessary mounting hardware and instructions for both temporary and permanent mounting.
   c. Provide temporary mounting means to allow user to check proper performance and relocate as needed before permanently mounting sensor. Temporary mounting method to be design for easy, damage-free removal.
8. Meets California Title 24 requirements.

2.13 ACCESSORIES

A. Emergency Lighting Interface:
   1. Product: Lutron Model LUT-ELI.
   2. Provides total system listing to UL 924 when used with lighting control system.
   3. Senses all three phases of building power.
   4. Provides an output to power panels or digital ballast interfaces if power on any phase fails and sends all lights controlled by these devices to an emergency light level setting. Lights to return to their previous intensities when normal power is restored.
   5. Accepts a contact closure input from a fire alarm control panel.

B. Provide power supplies as indicated or as required to power system devices and accessories.

2.14 SOURCE QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Factory Testing; Lutron Standard Factory Testing:
   1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
   2. Perform full-function factory testing on 100 percent of all ballasts and LED drivers.
   3. Perform factory audit burn-in of all dimming assemblies and panels at 104 degrees F (40 degrees C) at full load for two hours.

PART 3 EXECUTION

3.1 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those Standards.

B. Install products in accordance with Manufacturer's instructions.

C. Provide dedicated network between lighting management system computer and lighting management hubs.

D. Define each dimmer/relay load type, assign each load to a zone, and set control functions.

E. Sensor Locations:
   1. Where Lighting Control Manufacturer Sensor Layout and Tuning service is specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS", locate sensors in accordance with layout provided by Lighting Control Manufacturer. Lighting Control Manufacturer may direct Contractor regarding sensor relocation should conditions require a deviation from locations indicated. Where Lighting Control Manufacturer Sensor Layout and Tuning service is not specified, locate sensors in accordance with Drawings.

F. Ensure that daylight sensor placement minimizes sensor view of electric light sources. Locate ceiling-mounted and luminaire-mounted daylight sensors to avoid direct view of luminaires.

G. Lamp Burn-In: Operate lamps at full output for prescribed period per Manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

H. LED Light Engine/Array Lead Length: Do not exceed 100 feet (31 m).

I. System and Network Integration Consultation; Lutron LSC-INT-VISIT: Include as part of the base bid additional costs for Lighting Control Manufacturer to conduct meeting with Facility Representative and other related Equipment Manufacturers to discuss equipment and integration procedures.
   1. Coordinate scheduling of visit with Lighting Control Manufacturer. Manufacturer recommends that this visit be scheduled early in construction phase, after system purchase but prior to system installation.

J. Identify system components in accordance with Section 260553.

3.2 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Manufacturer's Startup Services; Lutron Standard Startup Services:
   1. Manufacturer's Authorized Service Representative to conduct minimum of two site visits to ensure proper system installation and operation.
   2. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
   3. Conduct second site visit upon completion of lighting control system to perform system startup and verify proper operation:
      a. Verify connection of power wiring and load circuits.
      b. Verify connection and location of controls.
      c. Energize lighting management hubs and download system data program.
      d. Address devices.
      e. Verify proper connection of panel links (low voltage/data) and address panel.
      f. Download system panel data to dimming/switching panels.
      g. Verify system operation control by control.
      h. Verify proper operation of Manufacturer's interfacing equipment.
      i. Verify proper operation of Manufacturer's supplied PC and installed programs.
      j. Configure initial groupings of ballast for wall controls, daylight sensors and occupancy sensors.
      k. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "DIGITAL-NETWORK LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS".
      l. Train Owner's Representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
      m. Obtain sign-off on system functions.
   4. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.3 COMMISSIONING

A. See Section 019113 - General Commissioning Requirements for Commissioning requirements.

B. Title 24 Acceptance Testing Service; Lutron LSC-SPV-DOC-T24: Include as part of the base bid additional costs for Lighting Control Manufacturer to perform lighting control acceptance testing in accordance with CAL TITLE 24 P6. Submit required documentation.

3.4 CLOSEOUT ACTIVITIES

A. See Section 017800 - Closeout Submittals, for closeout submittals.

B. See Section 017900 - Demonstration and Training, for additional requirements.

C. Demonstration:
   1. On-Site Performance-Verification Walkthrough; Lutron LSC-WALK: Include as part of the base bid additional costs for Lighting Control Manufacturer to provide on-site demonstration of system functionality to Commissioning Agent.

D. Training:
   1. Include services of Manufacturer's Authorized Service Representative to perform on-site training of Owner's Personnel on operation, adjustment, and maintenance of lighting control system as part of standard system start-up services.
      a. Include training on software to be provided:
         1) Configuration software used to make system programming and configuration changes.
         2) Control and monitor.

3.5 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Software Maintenance Agreement; Lutron LSC-SMA: Include as part of the base bid additional costs for Manufacturer to provide quarterly compatibility testing results for PC-based lighting control software and new patches issued for Microsoft Operating System, Database, and Browser tools.
   1. If new Microsoft patches create a software conflict, Manufacturer to provide lighting control software patches to ensure continued operation.

C. System Optimization Visit; Lutron LSC-SYSOPT: Include as part of the base bid additional costs for Lighting Control System Manufacturer to visit site 6-months after system start-up to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION 260943

090816/1010006

SECTION 261005
POWER DISTRIBUTION (OVER 600 VOLTS)

PART 1 GENERAL

1.1 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. Additional Requirements for Conductors and Raceways of Circuits Greater than 600 volts.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Product Data Sheets for all Wire, Conduit, Fittings, Splicing, and Terminating Materials.

B. Submit Material List for all Conduit and Fittings.

C. Perform Factory High Voltage AC and DC and Corona Level Conductor Tests per ICEA Standards on each length of cable. Submit Certified Reports of Factory Tests, together with all data necessary to determine that cable is as specified, including type of conductor, AWG size and stranding; type and thickness of insulation and jacket; type of shielding; insulation resistance constant corrected to standard temperature; voltage rating. Use standard ICEA terminology in reports.

D. Submit the AEIC Qualification Test Reports Data.

1.3 FACTORY TESTING

A. Final Testing on Shipping Reel

Each completed length of conductor shall be subjected to a 1-minute AC test voltage prior to shipping after the conduction's have been placed on the shipping reels. AC test voltage shall be 25kV for 5/8kV insulated conductors and 34kV for 15kV insulated conductors.

B. Conductors, which fail the specified Factory Tests, are unacceptable and shall not be used. Submit eight copies of Factory Test Reports for review. Conductors shall not be installed until the Architect has reviewed the Factory Test Reports.

PART 2 PRODUCTS

2.1 CONDUCTORS

A. General
   1. Cables conductor sizes and quantity as indicated on Drawings.
   2. Cable shall be in compliance with the latest applicable requirements of UL, OSHA, NEMA, NEC, ASTM, AEIC and ICEA for installations indicated.
   3. All cable must have been manufactured within 1-year of award of Contract. As manufactured by Okonite "Okoguard-Okoseal"; or Prysmian Cable Systems; or Kerite Company.
   4. The following minimum information shall be factory imprinted on the cable jacket, a minimum of 36-inches on center.
      a. Manufacturers name.
      b. Insulation type and voltage level.
      c. Date of manufacture.

d. Conductor size and material.
e. Jacket type.

5. Cable shall be shipped and stored on cable reels and cable ends shall be sealed watertight at all times. Cables not so shipped, stored and sealed shall be rejected.
6. The cable shall be rated 105 degrees C for normal operation, 140 degrees C for emergency overload operation, and 250 degrees C for short circuit conditions.
7. UL listed as type MV-105 per UL-1072.
8. Jacket shall be oil resistant, complying with “Oil Resistant-1” and “Oil Resistant-2” UL 1072.

B. Power Cable Construction (Phase to Phase System Operating, Voltage, 2000 volt thru 5000 volt.)

1. Conductor – single conductor copper, Compact Stranded per ASTM B496, ICEA S-68-524, NEMA WC-8 and UL-1072.
2. Conductor Strand Screen – continuous extruded layer over the conductor per ICEA S-68-516, AEIC CS-6, NEMA WC-8, and UL-1072.
3. Insulation – continuous Ethylene Propylene Rubber (EPR). 115 mil for 8kV 100% insulation level, 5kV 133% insulation levels. Extruded over and bonded to conductor strand screen meeting or exceeding ICEA S-68-516, NEMA WC-8, AEIC CS-6, and UL 1072.
4. Insulating Screen – continuous, extruded, semi-conducting screen over the insulation meeting or exceeding ICEA S-68-516, AEIC CS-6 and UL-1072.
5. Shield – 5-mil copper tape shield applied with not less than a 12.5% overlap and full 100% coverage over insulation screen. Per UL-1072, ICEA S-68-516, and NEMA WC-8 (shield shall be omitted on cable utilized as a neutral conductor).
6. Jacket – non-metallic black sunlight resistant PVC (polyvinylchloride) extruded over shield, per ICEA S-68-516, NEMA WC-8, and UL-1072.

C. Power Cables Construction (Phase to Phase System Operating Voltage 5001 volt thru 13000 volt).

1. Conductor - single conductor copper, Compact Stranded per ASTM B496, ICEA S-68-524, NEMA WC-8, and UL-1072.
2. Conductor strand screen - continuous extruded layer over conductor per ICEA S-68-516, AEIC CS-6, NEMA WC-8, and UL-1072.
3. Insulation - continuous Ethylene Propylene Rubber (EPR). 220 MIL for 15kV, 133% insulation levels. Extruded over and bonded to conductor strandscreen meeting or exceeding ICEA S-68-516, NEMA WC-8 AEIC CS-6, and UL- 1072.
4. Insulating screen - continuous, extruded, semi-conducting screen over the insulation meeting or exceeding ICEA S-68-516, AEIC CS-6, and UL- 1072.
5. Shield - 5-mil copper tape shield applied with not less than a minimum of 12.5% overlap and 100% coverage over insulation screen. Per UL 1072, ICEA S-68-516, NEMA WC-8.
6. Jacket - non-metallic black sunlight resistant PVC (polyvinylchloride) extruded over shield, per ICEA S-68-516, NEMA WC-8, and UL- 1072.

2.2 CONDUCTOR SPLICING AND TERMINATIONS

A. General

1. All material used shall be compatible with specific cable installed and shall be rated for 90 degrees centigrade normal operation, 130 degrees centigrade emergency overload operation, and 250 degrees centigrade for short circuit conditions.
2. Shall be in compliance with Manufacturer's standard recommendations. Splices shall be suitable for continuous immersion in water.
3. Splices and terminations shall meet Class-1 requirements.
4. The splices and terminations shall match and be compatible with the respective cable type, insulation, shielding and jacket.
5. Ground cable shield at each splice and termination.

B. Splices - (Built-Up Tape Type, for PVC Jacket Cables)

1. General
   a. Conductors shall be joined by "T" type, "Y"-type or inline (as applicable) compression, tinned copper sleeves connectors, installed with hydraulic "die" compression tool. Sleeves shall have chamfered ends, and cable stops to properly center on conductor. Ampacity equal to conductor. 3M- "Scotchlok", Burndy-"144 splice".

2. Built-up tape type for PVC jacket cables
   a. Individual splices shall be hand laid built-up self-vulcanizing, insulating tape, with stress relief. Splice kits as manufacturing by Kerite, 3M or Plymouth.
3. Polymeric cable splices kits:
   a. Heat shrink or mechanical preshrink (cold shrink) uniform cross section, with linear stress relief and dielectric insulating layers; metallic shielding across splice with ground lead out; overall jacket sleeve.
   b. Comply with IEEE 48 and 404; seal environmental to provide ANSI C119.2 water immersion test, latest revisions.
   c. Outdoor weather tight construction, anti-tracking ultraviolet solar radiation overall jacket protection. As manufactured by Raychem or 3M.

C. Terminations (Indoor built-up tape type, or polymeric termination kit for PVC jacket cables where cable terminator is not specified with equipment).
1. General
   a. Conductor shall be terminated with compression tinned copper seamless, barrel terminal lugs installed with hydraulic "die" compression tool. Terminal lug shall be 4-bolt spade lug type for bus connections or stud type for other locations. Burndy- "Hylug" or 3M- "Scotchlok".
2. Individual cable terminations shall be hand laid, built-up self-vulcanizing insulating tape with stress relief. Termination kits as manufactured by Kerite, 3M or Plymouth.
3. Polymeric cable termination kits:
   a. The incoming line feeders shall be provided with premolded insulated primary conductor termination kits. The termination kits shall conform properly to compatible with the conductors shown on the Drawings, including out of round cables as defined on AEIC and ICEA heat shrink or mechanical preshrink. The termination shall environmentally seal the cable jacket. Stress relief and feeder insulation shield grounding. Provide anti-tracking skirts on terminations.
   b. Provide 4-bolt copper spade lug cable connector compression connectors, and bolt each termination to respective phase lug landings. Grade 5 Hex head bolts and Belleville washers. As manufactured by 3M or Raychem.
4. Terminations shall comply with IEEE-48- (latest revision) Class 1 conductor terminations shall all be 15kV Class:
   a. AC withstand input (kV)..... 50
   b. DC withstands, 15-minute (kV) 75
   c. Partial discharge, minimum kV for 3pC or less 15.6
   d. BIL basic impulse withstand..... 1.2 x 50 micro seconds crest ..... kV (outdoor) 110
   e. BIL basic impulse withstand1.2 x 50 micro seconds crest..... kV (indoor) 95
   f. Continuous current rating (normal, overload, emergency) .....equal to connected cable
   g. Nominal overall length (inch)..... 15.5
   h. Wet withstand, 10 seconds (kV rms) 45
   i. Dry withstand, 6 hours (kV rms)..... 35
   j. To match connected cable and type.
5. Provide a minimum of two conductor cable landings for each incoming line phase termination.
6. Provide removable, electrically insulated, "boots" to completely cover each termination connection bolted lug landing and bus connection.
7. Primary cable supports shall be provided to eliminate any strain on cable terminations.

2.3 SEPARABLE INSULATED CONNECTOR, ELBOW CABLE TERMINATORS AND APPARATUS BUSHING WELLS

A. General
1. Separable insulated connector system cable terminators shall be non-load break, molded thermoplastic and molded rubber 200 amp for wire sizes smaller than 4/0 AWG, 600 Ampere for wire sizes 4/0 AWG and larger, unless noted otherwise on Drawings.
   a. De-energized dead-break bolted connects, unless noted otherwise on Drawings.
2. Assemblies shall be rated for continuous submersion in 10 feet of water.

3. Provide terminators to accommodate the connecting feeder cable type and size.
4. Insulated, shielded, dead front, safety plug, one for each cable phase, complying with ANSI C119 and 386 latest revision. Shall be designed, manufactured, and tested to comply with IEEE-386 and IEEE-592 latest revisions. Suitable for "insulated-hook-stick" insertion and removal.
5. Elbows and apparatus bushing wells shall be mechanically and electrically compatible. Shall be inter-changeable operation between multiple Manufacturers.
6. Provide "parking" stands for each termination and phase, in each location.
7. As manufactured by G & W Electric; or Elastimold/Thomas & Betts.

B. Electrical Ratings

	System Voltage Electrical Ratings	System Voltage 2400V or 4160V	above 4160 volt to 13000 volt
1.	Line to ground rating	8.3kV	15.2kV-RMS
2.	Impulse withstands voltage BIL.	95kV-RMS	125kV
3.	Withstand voltage, 60Hz AC	34kV-RMS	40kV-RMS
4.	Withstand voltage D.C. 15 minute	53kV D.C.	78kV D.C.
5.	Corona Extinction	11kV D.C.	19kV D.C.
6.	200 amp elbow - momentary withstand for 10Hz	10,000AMP-Sym.	10,000AMP-SYM
7.	600 amp elbow – momentary withstand for 10Hz	18,000 Sym.	18,000 Sym.
8.	Continuous load current	200AMP-RMS (600 AMP-RMS)	200AMP-RMS (600 AMP-RMS)

C. Elbow Connector Test Point
1. Each elbow shall be provided with front accessible capacitive coupled test point.
2. The test point shall include a protective, removable, voltage insulated, snap-in cap to provide test point access.

D. Fault Indicator
1. Provide a fully automatic, capacitance coupled electrical, visual fault indicator installed in each test point.
2. Self-powered through capacitive coupling when installed in the elbow test point.
3. The fault current indicator pick-up current and operating speed shall be selected based on upstream relay/fuse types and settings, for correct fault indicates. Additionally, it shall prevent false fault-indication caused by normal motor, transformer and conductor charging in rush (turn-on) currents.

E. Multi-Point-Junctions
1. Shall distribute primary voltage multiple circuit taps for separable elbow-connectors. Modular, premolded, insulated, with internal 600 ampere single phase copper distribution bus.
2. Provide quantity of multiport connector ports on each junction for multiple insulated separable elbow connector attachments, plus spares. Electrical characteristics and insulation characteristics shall match the elbow connectors.
3. Fully shielded and fully insulated and fully submersible in water when energized.
4. 304 – stainless steel surface mounting brackets with ground lug. Provide two (2) integral (left-right) "parking" stands for elbow connectors.
5. Provide bushing inserts for electrical and mechanical compatibility with respective elbow connectors.
6. Provide not less than three multi-point-junction assemblies at each location; Phase-A, Phase-B, and Phase-C. Provide not less than two additional spare connection ports on each multi-point-junction assembly for future use.
7. Interface spacing between ports shall be uniform and compatible with respective elbow connectors.

2.4 CONDUIT (ADDITIONAL REQUIREMENTS)

A. Aluminum Conduit, Flexible Metal or Non-metal Conduit and Electrical Metallic Tubing shall not be used.

B. Rigid Galvanized Steel Conduit shall be used for all exposed and concealed conduit above grade and for bends and risers below grade.

C. Nonmetallic Conduits Schedule 40 PVC or type "EB" shall be used for all ducts below grade, and shall be completely concrete encased in a 3-inch concrete envelope the entire length, including below building slabs.

D. Bury Underground Conduit a minimum of 36 inches to top of concrete encasement below final finish grade, including under building slabs.

E. Provide End Bells on All Conduit Terminations.

F. Condulets shall not be used.

G. Provide Molded, Snap Together, Conduit Support Spacers a minimum of 5-feet on center in all underground multiple conduit installations.

The spacing between conduits located below grade shall be as follows:

1. Two inches between conduits for circuits operating above 600 volts.
2. Six inches between conduits for circuits operating above 600 volts and conduits for circuit operating below 600 volts.
3. Twelve inches from conduits for any Utility Company circuits and pipes.

2.5 FIREPROOFING

A. The Cable Fireproofing shall consist of a hand applied flexible tape, conformable fabric coated with flame retardant and separate securing tape wrap. As manufactured by 3M or Plymouth.

B. The Tape shall be a flexible polymeric coating and/or chlorinated elastomer not less than 0.03 inch thick, weighing not less than 2.5 pounds per square yard.

C. The Tape shall be non-corrosive to the cable jacket.

D. The Tape shall be self-extinguishing shall not support combustion, and shall withstand high current fault ARC temperatures of 13000 degrees Kelvin for 70Hz.

E. The Tape shall not deteriorate when subjected to oil, water, salt water, sewage and fungus.

PART 3 EXECUTION

3.1 CONDUCTORS IN RACEWAYS

A. Conduit Preparation

1. Metallic conduit shall be reamed and cleaned to remove metal cuttings, fillings and cutting oil.
2. Rod all underground raceways, including existing raceways to be used under this Contract, with approved test and flexible mandrels to remove all obstructions. Use test mandrels at least 12-inches long, ¼-inch less than diameter of duct at center, tapering to ½-inch less than duct size at ends. Do all cleaning and testing in the presence of Owner's Representative.
3. If test mandrels cannot be pulled through Raceways Contractor shall perform the following to clear the raceways.
   a. Force rigid or semi-rigid rods through the raceways to clear the obstructions from one or both ends of the raceway.
   b. Force a power driven rotating router device with small diameter cutting blades, in incremental stages to a cutting blade diameter approximately ⅛-inch smaller than the raceway inside diameter.
   After clearing the raceway of obstructions pull a test mandrel or brush through the raceway to clear the remaining debris from the raceway.

B. Cable Lubrication:
   1. Cable pulling lubricants shall be specifically approved by the Cable Manufacturer. The following lubricants shall be used where approved by the Cable Manufacturer.
      a. Slip X -300, American Colliod Co.
      b. Bishop #45, Bishop Electric.
      c. MacLube CA51, MacProducts.
      d. Minerallac H2B,- Minerallac Electric.
      e. Winter grade #7437-PC, General Machine Products.
      f. Gel-lube 7/5, Cable associates.
      g. Polywater, A, C, G - American Polywater.
   2. Lubricants shall be continuously applied as cable enters raceway.

C. Pulling Tensions "EPR" Insulation PVC Jacket, Copper Conductors.
   1. The maximum pulling-in tensions and stresses on the cable must not exceed the undermentioned values when pulling the cable.
      a. The maximum pulling stress in pounds (tension), shall not exceed 0.008 times the CM (Circular Mil) area of the conductor when pulled with a pulling eye attached directly to each copper conductors, (i.e. (500,000 MCM) x (.008) = 4000 pounds).
      b. The maximum pulling stress shall not exceed 1000 pounds for non-leaded cables when pulled with a Kellums or Greenlee type basket grip on each conductor but in any case shall not exceed item (a) above.
      c. The cable sidewall pressure shall be defined as the pulling tension on the cable out of a bend, expressed in pounds divided by the radius of bend expressed in feet. The maximum cable side wall pressure (pulling tension) in pounds shall not exceed 400 times the raceway bend radius in feet. But in any case shall not exceed ‘a’ and ‘b’ above (i.e. (4 feet conduit radius) x (400) = 1600 pounds maximum pulling tension at the 4 feet conduit bend).
      d. Pulling tension calculations shall be submitted to ENGINEER prior to pulling any cable, for each cable run in excess of 100 feet and/or 180 degrees in bends. Similar runs need not be recalculated (i.e. same quantity and type of bends and/or length).
   2. A dynamometer to measure pulling tension shall be used on all cable runs in excess 200 feet or with more than 180 degrees in bends. The actual pulling tension value shall be calculated and recorded for each pull.
   3. Pulling eyes on each conductor shall be used for cable runs in excess of 100 feet or more than 180 degrees in bends, between pull points.

D. The Minimum Radii to which the installed cables can be bent for safe electrical operation and without danger of physical damage to the cable insulation, metallic shielding tapes, and/or outer jacketing materials shall not be less than 12 times the diameter over the finished cable jacket. Bends shall not be made in splices or terminations.

E. Installation
   1. Do not pull conductors until factory test reports have been submitted and reviewed.
   2. The attachment of the pulling device to the conductor pulling eyes or basket grips shall be made through a swivel connector.
   3. The attachment of pulling devices directly to the cables shall be with individual basket grips over each cable jacket or individual pulling eyes attached directly to each cable conductor. Securely tape cable ends to prevent moisture or pulling compound from penetrating cable.
   4. The Contractor shall ensure that the high voltage cables are fed straight into the raceway taking care to avoid short bends, sharp edges and cable "cross-overs".
   5. All lashings used for temporary bunching of the individual cables shall be removed before the cables enter the raceway. Lead out the cables at all manholes, pullboxes and conduits taking care to feed them in again by hand for the next run. Cables shall not be pulled directly around a short right angle bend.
   6. For each cable pull where a cable direction change is required flexible feed-in tubes, pullout devices, multi-segmented sheaves etc. shall be used to insure proper cable pulling tensions and side wall pressures. Any device or surface the cable comes in contact with when under pull-in tension shall have a minimum radius 50% greater than the final specified minimum installed cable-bending radius. The maximum possible size radius sheaves and feed-in tubes, usable in the available working space, shall be provided in all situations, to insure the minimum

possible cable sidewall pulling pressure. Do not use devices with multi-segment "roller" type sheaves.

7. Cable lengths over 50 feet shall be machine pulled not hand pulled. Cables shall be pulled in a continuous, smooth operation without jerking or stop-start motion after initiation of pull. Maximum cable pulling speed shall be less than 50 feet per minute. Minimum cable pulling speed shall be greater than 15 feet per minute.
8. Cables shall be pulled straight into or out of the raceway without bends at the raceway entrance or exit. Pull in cable from the end having the sharpest bend (i.e., bend shall be closest to reel). Keep pulling tension to minimum by liberal use of lubricant, hand turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one at manhole or pullhole during this operation. Cables shall be pulled directly from cable reels.
9. Cables shall be trained or racked in trenches, vaults, manholes and pull boxes with consideration given for the minimum specified bending radius of the cable and the possibility of cable movements due to load cycling. The cables shall be racked and supported in such a manner that adequate space is allowed for splicing and the cables shall always be fanned out from the duct or conduit so as not to cross other ducts conduits or cables. To prevent damage from falling objects or personnel entering the manhole the cables shall not pass directly under the manhole opening.
10. Cable shall be supported in manholes; pull boxes and vaults a minimum of 18-inches on center with cable racks. Provide hot dip galvanized, T-slot racks and support arms. Secure cables to racks with porcelain supports for each cable on the racks. Loosely lash cables to racks. Splices shall be directly supported, on racks. Do not install cables more than one feeder on the same rack hook.
11. Cables shall be routed the long way around manhole, pullhole, etc. unless noted otherwise.
12. Existing conductors shall be protected at all times when Contract Work occurs in the same area, including but not limited to pullboxes, vaults manholes, cable trenches etc. Provide temporary electrical insulating blankets and barriers over existing conductors to reduce the possibility of accidental mechanical damage to existing conductors.

F. Movement, Storage, and Handling of Cable

1. Reels of cable shall not be dropped from any height, from trucks or other transporting equipment.
2. Lift and move cable reels using following methods:
   a. Crane or boom type equipment-insert shaft (heavy rod or pipe) through reel hubs and lift with slings on shaft, with spreader or yoke to reduce or avoid sling pressure against reel head.
   b. Forklift type of equipment may be used to move smaller, narrower width reels. Fork times should be placed so that lift pressure is on reel heads, not on cable, and shall reach all the way across reels so lift is against both reel heads.
   c. Reels may be moved short distances by rolling. Reels shall be rolled in the direction indicated by arrows painted on reel heads. Surfaces over which the reels are to be rolled shall be solid clear or debris, and also clear of protruding stones, humps, etc. which might damage the cable if the reel straddles them.
3. Storage of Reels of Cable
   a. Cable ends shall be sealed prior to shipment to prevent moisture entry into cable. Cable ends shall remain sealed at all times including during installation. Where ends seals are removed, reseal cable ends by stripping cable finishes back 2-inches down to insulation. Then apply four layers of an insulating tape criss-cross over the cable end and carry back at least 4-inches onto cable outer finish. Add a containing cover of two layers of vinyl electrical tape completely over the end seal.
   b. Cable reels shall be shipped with factory applied lagging (protective cover) left in place until removal is absolutely necessary. Additional covering such as tarpaulin, plastic sheeting, etc. shall be used if cable is to be stored outdoors.
   c. Store reels of cable on a firm surface, paved, or on planking to prevent settling into soft ground.
   d. Use fencing or other barriers to protect cables and reels against damage by vehicles or other equipment moving about in the storage area.

G. Cable Testing

1. Contractor shall have an independent Testing Laboratory perform a high voltage DC acceptance test on each phase or leg of cables in accordance with ICEA Standards S-19-81, latest revision. Certified Test Reports shall be submitted to Engineer in the form of time versus current graph showing initial leakage current after test voltage is applied and for each 15 second interval up to 1-minute and for each one minute interval thereafter. Each graph shall be identified to correspond with the Cable Section and feeder name. Information on temperature, humidity and type of test equipment used during test shall also be submitted.
2. Cables shall be tested as follows:
   a. Each segment and phase shall be tested after installation and prior to splicing or terminating to other equipment or cables.
   b. Each conductor feeder and phase shall be tested after splicing to other new cables is completed, and prior to connection to equipment or other existing cables.
   c. Do not perform D.C. high voltage cable acceptance test into existing conductors, new or existing equipment, connected to the cables being tested.
3. Certified Factory Test Reports performed in accordance with ICEA S-19-81, Tables 2-12 and 6-17. Corona and AC/DC Tests shall be submitted with Shop Drawings for the specific cable to be installed.
4. Field test procedure:
   a. Set up test equipment. Do not connect test lead to cables, but temporarily hang the lead free with a plastic bag over the clip. Raise the voltage to the same final level as the cables test voltage. The leakage current seen on the DC meter is leakage in the test lead, and shall be subtracted from the readings taken later during the cable test. Shut the set off and discharge the lead.
   b. Apply the test voltage to each phase separately, making sure that all other phases, all cable shields, any armoring or neutral conductors, and other nearby metallic objects are grounded to prevent voltage pick-up.
   c. Raise the test voltage from zero gradually in 10% steps to 80% of the final test voltage, then in 5% steps to final test voltage, which shall be left on for 5 minutes. Take current readings at each step after current has been stabilized approximately one-minute intervals. Take current reading each minute period. Record each step voltage/current and time interval. Plot readings on graph paper.
   d. During the test if a breakdown is indicated by a sudden or continuous increase in current, de-energize, disconnect and isolate the trouble. Remedy problem, completely disassemble and redo any defective cable terminations or splices. Retest cable, if breakdown is again indicated, remove, discard and replace defective cable and retest replacement cable. Defective cable shall be removed from site and shall not be reused.
   e. Upon completion of a successful test, shut down the test set and allow the voltage to decay to one-fourth the full value. Record the decay time.
   f. Solidly ground the conductor and allow the ground to remain in place for a period at least as long as the test time.
   g. Repeat the same test sequence for each phase cable and cable section.
   h. Proper precautions shall be taken to eliminate "end corona" during the test procedure. The leakage currents and the voltage decay times should be fairly similar for the individual phases of the same cable circuit. Also, a graphic plot of the current versus voltage values of the step-rise test should show a reasonably straight line (equal increments of current rise for equal increments of voltage increases), the current readings always being taken after the same duration of time (one minute) after reaching each voltage level. To insure proper testing procedures the Contractor shall do the following:
      1) The cable ends (or terminations) are clean and dry.
      2) The cable or terminal ends are as far away from surrounding structures as practical.
      3) The creepage distance from conductor back to cable shield is at least 1" for each 5kV of test voltage (this applies to newly installed cable, which has not yet been terminated).
      4) The irregularly shaped clip or connector where the test lead joins to the cable is wrapped with a few layers of plastic sheet to form a smooth tube to reduce corona.
      5) The free ends of cable have a glass jar or plastic bag over the end to reduce corona.
   i. The final D.C. test voltages for shielded cable shall be 30kV for 5kV or 8kV cable and 56kV for 15kV cable.

3.2 ARC PROOFING (FIREPROOFING)

A. All Wires and Cables which will carry current at 600 volts or more in manholes, pullboxes, and vaults shall be fireproofed.

B. Strips of Fire Proofing Tape approximately 1/16 inch thick by 3 inches wide shall be wrapped tightly around cable spirally in wrapping. The tape shall be applied with the coated side toward the cable and shall extend one inch into the ducts. To prevent unraveling, the fireproofing tape shall be spirally "Half-Lap" wrapped the entire length of the cable.

C. Fire Proofing shall be applied separately on each individual conductor. Secure fire proofing with two layers of spirally wrapped glass cloth electrical tape.

3.3 CABLE SPLICES AND TERMINATIONS

A. Cable Splicing and Terminations shall be performed by Personnel with a minimum of 5 years-qualified experience with specific splicing and termination methods used. Submit letter-certifying qualifications.

B. Each Conductor shall be spliced in each manhole and pullbox whether or not shown on the Drawings. No splices or terminations will be allowed in conduit or ducts.

C. Cable Shield shall be brought out and grounded at each splice and termination point to the equipment bond grounding system.

D. Splices (Built-Up Tape Type for PVC Jacket Cables)
   1. Cables shall be striped, tapered rasped with creepage distances per Manufacturer recommendations. Apply fill sealing putty on conductor compression sleeve indents and conductor, prior to beginning of splice taping.
   2. Conductor compression connectors shall be crimped with tools and specifically designed for the connector.
   3. Apply tape over conductor and connector sleeve.
   4. Apply splicing cement to rasped insulation and insulation screen.
   5. Apply insulating tape.
   6. Apply friction tape over insulation tape.
   7. Apply conducting fabric tape.
   8. Apply open spiral of tinned copper wire braid to carry shield continuity across the splice. Tack solders to 5-mil copper shield tape on each side of splice an additional single ground braid. Ground braid shall be brought out at splice, minimum 18-inches long and connected to ground bonding conductor, bind down braid with friction tape.

E. Terminations (indoor built-up) Tape Type, for PVC Jacket Cables where cable terminator is not specified with equipment).
   1. Cables shall be striped tapered, rasped with creepage distances per Manufacturer recommendations.
   2. Conductor compression connectors shall be crimped with tools and dies specifically designed for the connector.
   3. Tack solder to 5 mil copper shield tape, tinned copper shield tape, Bind down with friction tape. Bring out approximately 18-inches of ground braid and connect to ground bonding conductor.
   4. Apply sealing putty at tape shield/insulation joint and connector lug indents.
   5. Apply insulating tape.
   6. Apply friction and electrical tape.
   7. Make lug seal applying insulating tape, friction tape and electrical tape.
   8. Apply friction and electrical tape.

F. Polymeric Cable Splice Kits and Termination Kits
   1. Install in strict compliance with the Manufacturer instructions.

3.4 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Each Cable and Cable Tap shall be identified with nametags in manhole pullboxes, terminations and vaults.

B. Identification Tags shall include the following information:
   1. Feeder name as indicated on Drawings (i.e. HV1, F4, MSB3 etc.).
   2. Conductor phase (i.e. phase A, or phase B, or phase C, or neutral).
   3. Installation month and date (i.e. 3/85, 4/78 etc.).
   4. Conductor size conductor type (copper or aluminum) and insulation type (i.e. 4/0 CU-EPR, 500 AL VCL, etc.).
   5. Insulation voltage (i.e. 5kV, 8kV, 15kV, etc.).
   6. Feeder taps to equipment or building shall also be identified with equipment name or building (i.e. library, SW1, XMRA, etc.).

C. Tags shall be ⅛-inch thick 98% lead, approximately 2-inches square with chamfered corners. Two holes shall be drilled for attachment to primary cable. Lettering shall be ⅛-inch high, engraved or die stamped. Attach tags to primary cables with two #14 AWG (THWN insulated) solid copper conductors "twist-tied", with insulated CAP wire-nut on the tie-wire ends, to cover sharp edges of tie-wire conductor.

D. Alternate Identification Tags, at the CONTRACTOR'S option in lieu of lead tags. Provide polypropylene tag holders with interchangeable, yellow polypropylene tags with black alphanumeric characters sets. Characters shall be a minimum of 0.25-inch high. As manufactured by Almetek industries "EZTAG" - Ledgewood, New Jersey, William Frick & Co. - Vernon Hills, ILL.

E. Hot-Phasing

   The Contractor shall perform and certify phase rotation testing on connections to existing/new circuits and equipment. Testing shall verify equipment and conductors are correctly "Hot-Phase" sequenced, to allow interconnecting and inter switching of any "Hot" circuits of like voltage with correct phase sequencing. The Contractor shall correct any phasing sequence found to be incorrect as a result of work performed by this Contract.

3.5 GROUNDING ADDITIONAL REQUIREMENTS

A. Raceways
   1. Provide all raceways and conduits containing circuits operating at line to line or line to ground voltages exceeding 600 volts with an internal dedicated equipment ground/bond wire, copper conductors, 600 volt insulation.
   2. Typical for metallic and non-metallic raceways and conduits.

B. Splices and Terminations
   1. Provide cable shield ground/bond lead out at each conductor splice and termination location. Extend and connect to respective equipment ground bus; each pull box/manhole respective ground rods and feeder ground conductors; etc.

END OF SECTION 261005
070317/1010006

SECTION 261105
SUBSTATION

PART 1 GENERAL

1.1 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.

B. Scope (PCB Transformer Replacement)

1. Furnish and install transformer for the purpose of replacing existing PCB transformers. The furnished dry type transformer shall be fabricated in such a manner as to be realigned with the existing primary and secondary electrical equipment.
2. Contractor and Manufacturer's Engineering Representative shall be required to make site visit to ascertain critical dimensions for replacing PCB liquid or PCB contaminated transformers and to ensure proposed transformer replacement meets Local, State and NEC Codes working clearances.
3. Materials not normally furnished by the Manufacturer with the equipment shall be provided in accordance with other applicable Sections of these Specifications.
4. Contractor and Manufacturer shall be fully responsible to align new transformer into existing limited space including mating with existing primary and secondary switchgear and coordination to match existing bus and other termination using cables or insulated flexible links or bus connections.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all wire, transformers, device plates, switches, lamps, circuit breakers, relays, cooling equipment, timeswitches, disconnects, fuses and meters.

B. Provide nameplate engraving schedule.

C. Submit Detailed Shop Drawings including Dimensioned Plans, Elevations, Details, Interface Details, Schematic Single Line, Point To Point Control Wiring Diagrams and descriptive literature for all component parts. Submit Scaled Plans and Elevation View Drawings.

D. Submit Full-Scale Time/Current Transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays. Additionally, provide software to generate time/current curves of each circuit protection device.

E. 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 current 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, electric panels, unit substations, 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.

F. Submit Transformer Test Reports.

G. Factory Tests: Equipment tests - ANSI C37.20. Certified copies of Design Tests, Production Tests, and Conformance Tests of the switchgear shall be submitted and review the Project Site. In lieu of the above tests, a report of these tests previously performed on identical units of each rating will be acceptable.

1.3 APPLICABLE STANDARDS

A. The equipment shall be designed, tested, and assembled in accordance with the latest applicable Standards of CEC/ NEC, ANSI, IEEE, and NEMA and UL including not limited to the following latest revisions:
   1. ANSI C57.12.01, C57.12.50, C57.12.51, C57.12.54, C57.12.56, C57.12.57, C57.12.58, C57.12.90, C57.12.91, C57.12.96 and ST1 NEMA ST20, NEMA TR1-27, and NEMA TRI, NFPA 70:
   2. The entire unit substation assembly shall be UL listed and labeled.

B. All materials selected for the Manufacturer of the transformers shall be the best available for the purpose for which they are used, considering strength, ductility, durability and the best Engineering Practice.

C. Equipment, components/devices, switchboards, switchgear and transformers shall be manufactured by: General Electric; or Cutler-Hammer; or Square-D; or Siemens.

PART 2 PRODUCTS

2.01 GENERAL

A. Integrated and Tested Assembly
   1. The secondary unit substation shall be self-contained factory assembled, tested and coordinated unit consisting of incoming line section(s), transformer section, and secondary outgoing section(s), totally metal enclosed, free-standing housings.
   2. All sections shall be combined in close coupled steel structure having internal barriers segregating the incoming line, transformer and outgoing sections, into separate compartments.
   3. Provisions for jacking, lifting, skidding, and rolling shall be made as an integral part of the equipment design for all sections.
   4. Construction shall be left to right or right to left as indicated on the Drawings.
   5. Individual sections structure and the entire unit substation assembly shall be fabricated to comply with seismic earthquake occurring at the install location, without loss of continuous operation during an earthquake. Provide testing and documentation.

B. Structure
   1. The unit substation shall have structural anchor points permanently attached to the assembly, to provide for bolting the unit sections securely to the floor.
   2. Interconnections between the transformer, primary and secondary equipment sections shall be provided by the factory.
   3. The unit shall be front accessible for normal maintenance. Rear access of primary incoming cables and secondary outgoing cables shall be provided, top or bottom conduit entrance as indicated on Drawings.
   4. Ventilating openings in the enclosure shall be located to insure proper cooling at installed equipment location shown on the Drawings. Provide expanded metal screens on vent openings. Construction shall prevent entry of rodents into the unit substation interior, including rodent screens on bottoms of all equipment sections.
   5. External and internal surfaces shall be painted. Clean and prime coat all metal structural surfaces with hot phosphatized rust-inhibitor prime coat prior to application of high quality hard dried acrylic enamel finish. Standard Manufacturers color. All sections shall be the same color.
   6. A prominent nameplate bearing equipment ratings, tap-changing information, Manufacturer identification, and reference serial numbers shall be mounted on the front of the unit.
   7. Provide a continuous and permanent mimic-bus on the front of each equipment section to graphically show electrical power flow through the equipment.

C. Special Configurations
   1. Special consideration shall be required for installation to fit into limited space to include but not limited to, cutouts or flanged throats to facilitate mating with other primary and secondary switchgear and equipment (and/or coordination to match existing use and other terminations).

D. Seismic Earthquake and Wind Loading Withstand, Testing and Certification (Additional Requirements)
   1. The complete unit substation assembly; including attached circuit protection devices, transformer, switchboards/switchgear, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested for:
      a. Wind loading all outdoor equipment locations.
      b. Earthquake Seismic Zone-4 and CBC/IBC withstand, all indoor and all outdoor equipment locations.
   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 not less than as follows and as required by AHJ:
      a. 100MPH – West Coast States USA and Hawaii.
      b. 150MPH – East Coast States USA, Gulf Coast States USA and Alaska State.
      c. 90MPH – all other USA locations.
   5. Acceptance Test Seismic Qualification of proposed unit substations 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.

2.2 WEATHERPROOF ENCLOSURES

A. Equipment indicated as Weather Proof (W.P.) or outdoors shall be NEMA 3R, non-walk-in, tamper resistant construction. Provide full height hinged doors with provisions for padlocking the doors in the closed position.

B. Provide a nominal 300 watt sealed, resistance type, anti-condensation heater in each equipment section. Heaters shall be controlled automatically by Thermostats and humidistats. A circuit

breaker shall be provided to supply equipment buss secondary voltage to the heaters, all prewired by the Manufacturer.

C. Finish shall be electrostatically applied finish paint over iron oxide rust inhibitor primer. Finish color shall be Manufacturers standard color, olive green Munsel #7GY3.29/1.5. The bottom side and bottom 6 inches of the equipment shall be coated with 4 mil minimum thickness rust inhibitor undercoating over finish paint, on all interior surfaces. Finish withstand test without face corrosion or blistering:
   1. Salt spray withstand - 2000 hours ASTM B117.
   2. Humidity withstand - 750 hour ASTM D2247.

D. Exposed Hardware and Hinges shall be Stainless Steel type 302 or 304, tamper resistant.

2.3 BUSSING

A. Horizontal and Vertical Busses shall be full length. Busses shall have a minimum withstand rating equal to available fault current indicated on Drawings, plus a 25% additional capacity (safety margin). However, in no case shall the bus rating be less than 50,000 Amp, RMS symmetrical, secondary side: 50,000 amp, RMS symmetrical primary side, at indicated operating voltages.

B. Provide interconnected full capacity secondary neutral bus in each section with the same ratings and construction as the phase busses.

C. Provide Interconnected Ground Bus in each Section.

D. Provide Space, all hardware and mounting attachments for future devices as indicated on the Drawings.

E. Main Horizontal Bussing shall be full capacity in all Equipment Sections.

F. Vertical Riser Buss may be tapered, to not less than one third the ampacity rating of the main horizontal buss; but in no case shall the vertical buss be of less capacity than the sum of the frame size ampacities of overcurrent devices mounted in the respective sections including any indicated spares and spaces.

G. The Equipment Bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Bus shall be copper or extruded aluminum with silver-plated bus joints. The through buss shall have provisions for the addition of future equipment sections. The through bus supports, connections and joints shall be bolted with Grade 5 hex head bolts and Belleville washers to minimize maintenance requirements.

H. Primary Bussing shall be fully insulated with a factory applied, extruded bus insulating material. All primary bussing shall be supported on porcelain insulators. Primary bussing BIL shall be 95kV for 15kV Class and 60kV for 5kV and 2.5kV class.

I. The Minimum Bussing Capacity shall be rated for unit full load capacity plus the additional capacity with fan cooling installed, but in no case less then indicated on the Drawings.

2.4 INCOMING LINE

A. The Incoming Line shall be provided with factory filled porcelain "slip-on" type cable terminations for the incoming feeder entering the section as indicated on the Drawings, provide support brackets on equipment frame for cable terminators. Provide 4-bolt spade lug connector, bolt to bus with grade 5 HEX head bolts and Belleville washers.

1.	BIL	110 kV
2.	Current Rating	same as feeder cable
3	1 minute dry AC test	50 kV
4.	6 hour dry, AC test	35 kV
5.	10 second wet, AC test	45 kV
6.	15 minute dry, DC test	75 kV

7. Compatible with cable diameter, quantity and type as shown on Drawings.
8. Provide cross support channels with porcelain cable cradles for incoming feeder conductors.

B. The Primary Disconnect Switch(es) shall be load interrupting with quick-make, quick-break stored energy manual operating mechanism. Switches shall be 3-pole, two position gang operated with a current rating of 600 amperes continuous and full load break. Switches shall be designed to meet NEMA Standards for a Class-A device. Arc interruption shall take place in air, aided by de-ionizing arc chutes operating in conjunction with high speed moving arcing contacts.

C. A Door Mounted Viewing Window shall provide observation of switch contacts.

D. The Switch and all Components within the Primary Incoming Section shall have a minimum NEMA Basic Impulse Level (BIL) corresponding to the system voltage class of 60kV BIL (for 2.5kV Class and 5kV Class) 95kV - BIL (for 15kV Class) as indicated on the Drawings. 50,000 ampere RMS asymmetrical momentary fused withstand rating and 40,000 ampere RMS asymmetrical close and latch.

E. Means shall be provided to padlock the switch in the open or closed position.

F. Provide Lightning Surge Arresters Mounted inside the Compartment, one per phase distribution type, connected between the switch and fuses. Surge arrestors shall be non-fragmenting type and comply with ANSI-C62.1.

G. Non-expulsion current limiting primary fuses with a short circuit interrupting rating of 50,000 amperes RMS symmetrical shall be supplied fixed mounted on the load side of each switch pole. The fuse continuous current rating shall be in accordance with the Manufacturer's recommendation to adequately protect the transformer from damaging overloads and short circuits. Fuses shall provide a visible "Blown-fuse" indication. Fuses shall be removable from the front without special tools.

H. Access to Fuses While Energized shall be positively prevented through a mechanical interlock system which keeps the section front door locked closed when the switch is in the closed position. Provide warning-labels if switch/fuse “back-feed” may occur and provide mechanical/electrical interlocks between “main” secondary disconnect and primary switch/fuse to prevent access for the duration of the back feed condition.

I. Any Internal Parts that Remain Energized with the Switch Open shall be guarded by a fixed internal safety barrier to prevent inadvertent contact by Operating or Maintenance Personnel with the door open. Interphase insulating barriers shall be provided for the system voltage class, to isolate switch and fuse poles from each other and from grounded metal.

I. Incoming Line shall be close-coupled to the unit substation transformer.

2.5 TRANSFORMER SECTION (DRY TYPE VENTILATED)

A. A Three Phase, 60Hz AC, two Winding, Ventilated Dry Type Transformer shall be provided as part of the unit substation assembly. Transformers shall comply with NEMA TR-1 and TP-1 latest revisions.
   1. Refined Cold Rolled optimized Grain-Oriented (CRGO) electro-magnetic silicon steel fabricated transformer core (ANSI-M5 or better grade), insulated core laminations and finished to protect against corrosion and improve transformer operational efficiencies.
   2. Shall reduce the transformer core no load losses to approximately 0.18% or less of the transformer nameplate rating.

B. Insulation
   1. The insulation system shall be based on 220 degrees C insulating materials, vacuum pressure impregnated, non-hygroscope, thermosetting insulating varnish/resin. Transformer temperature rating of 150 degrees C rise. The transformer temperature rise rating shall be in a 40 degree C ambient, with an average ambient for any 24-Hour period of 30 degrees.
   2. The transformer core and coil assemblies shall be VPI – Vacuum Pressure Impregnated high temperature varnish/resin with not less than two standard full cycles of vacuum pressure

impregnation and drying process. Transformers employing “dip-and-bake” process are not acceptable.

3. Transformer insulation Basic Impulse Level-BIL rating.

Nominal Voltage	Primary- BIL	Secondary- BIL
12-kV Class	95kV	30kV
5-kV Class	60kV	30kV
2.4-kV Class	60kV	30kV

BIL Rating prior to use of surge arrestors.

4. Dry type transformers shall meet or exceed NEMA TP-1 (latest revision), Class-1 efficiency levels and shall be marked as energy efficient for United States Department of Energy and Environmental Protection Agency DOE/EPA “Energy-Star” Certification.

C. Transformer Impedance shall be NEMA standard but not be less than indicated on the Drawings or exceed the value indicated on the Drawings by more than 15% of the indicated value.

D. Load Rating

1. The ambient air (AA) self-cooling kVA rating, primary and secondary voltage ratings shall be as shown on the Drawings.
2. Provide automatic forced (FA) air fan cooling (AA/FA) to increase the transformer capacity to not less than 130% of the self-cooling (AA) rating.
3. All unit substation sections and bus capacity shall be increased to equal or exceed the forced air fan cooling transformer rating.

E. Taps (Deenergized Operation)

1. Taps shall be conveniently located at the front of the coils for accessibility.
2. Full kVA capacity primary taps shall consist of two 2.5% above normal and three 2.5% below normal voltage full load rated.
3. When dual primary voltage windings are specified, both windings shall have taps.

F. A Transformer Winding Temperature Gauge shall be provided, visible from the exterior of the transformer housing. An external resetable peak temperature pointer shall be incorporated in the gauge.

G. The Sound Levels (without forced air cooling sound contribution) shall be guaranteed by the Manufacturer not to exceed the following values:

1. 151 to 300kVA - 58dB
2. 301 to 500kVA - 60dB
3. 501 to 700kVA - 62dB
4. 701 to 1000kVA - 64dB
5. 1001 to 1500kVA - 65dB
6. 1501 to 2000kVA - 66dB
7. 2001 to 3000kVA - 68dB

H. The Transformer Core and Coil Assembly shall be completely isolated from the transformer enclosure. There shall be no metal to metal rigid contact. Vibration isolation pads shall be provided between the core and coil and the enclosure.

I. The Transformer Assembly and Transformer Core shall be visibly grounded to the ground bus with a flexible grounding conductor.

J. The Transformer Assembly, Transformer Core and Coil shall be earthquake restrained for the install location Earth Quake Seismic CBC/IBC rated.

K. Enclosure

1. For indoor applications, an air ventilated metal enclosure shall be provided. The base shall be structural steel of sufficient strength to permit jacking, rolling, and skidding in any direction. Removable panels shall be provided for access to the tap connections and for inspection and maintenance. Front and rear panels shall be provided with top and bottom ventilation openings backed with a mesh made of non-corrosive wire to provide adequate cooling airflow.
2. Outdoor application, an outdoor weather and tamper resistant air ventilated metal enclosure shall be provided. The base shall be structural steel of sufficient strength to permit jacking,

rolling, and skidding in any direction. Front and rear panels shall be provided with top and bottom weather resistant ventilation grills and rain-shields to provide adequate cooling air flow and to prevent rain and snow from entering the enclosure.

3. Provide rodent continuous shields on the transformer bottom.

L. Transformer Windings and Lead-outs shall be insulated copper or aluminum. Current carrying bolted connections shall incorporate Belleville compression type washers.

M. Electrostatic Shield: Provide full width, copper, and 100% electrostatic shield, between primary and secondary transformer windings on each transformer phase. Shields shall be low impedance/ inductance grounded to the transformer metal frame and shall attenuate common mode and transverse mode electrical noise.

N. Transformers shall be Rated K4 in accordance with IEEE-C57.110.

2.6 TRANSFORMER SECTION (EPOXY CAST COIL VENTILATED)

A. Transformer

1. A three phase, 60Hz AC two winding ventilated cast coil transformer (both primary and secondary winding). Shall be provided as part of the unitized assembly. Transformers shall comply with NEMA TR-1 and TP-1 latest revisions.
2. The transformer shall be of dry type non-hydroscopic epoxy resin vacuum cast coil construction. Solid epoxy-cast materials shall provide protection resulting from transformer exposure to severe load cycles (cold start to maximum load) and harsh environment/climates (freezing, heat, chemicals and contaminated air and air borne condensing moisture). Two-winding, 80 degree C rise above 40 degrees C maximum ambient temperature with a 30 degree C, 24 hour average in a NEMA enclosure as defined in NEMA ICS6 unless otherwise noted. 185 degree C rated insulation systems.
3. Transformer efficiency shall meet or exceed NEMA-TP1 (latest revisions) requirements, Class-1 efficiency levels and shall be marked as energy efficient for United States Department of Energy DOE/EPA “Energy-Star” Certification.
4. Transformer shall be Class AA (Ambient Air) self-cooling below 300kVA and Class AA/FA (forced air fan) for 300kVA and above.
   a. The (AA) self-cooling kVA rating, primary and secondary voltage ratings shall be as shown on the Drawings.
   b. A transformer winding temperature gauge shall be provided, visible from the exterior of the transformer housing. An external resettable peak temperature pointer shall be incorporated in the gauge.
   c. Provide automatic forced air fan cooling (AA/FA) to increase the transformer capacity to not less than 130% of the self-cooling (AA) rating.
   d. Solid epoxy-cast materials shall provide protection resulting from transformer exposure to severe load cycles (thermal cycling cold start to maximum load) and harsh environment/ climates (freezing, heat, chemicals and contaminated air and air borne condensing moisture).
   e. All unit substation sections and bus capacity shall be increased to equal or exceed the forced air fan cooling transformer rating.
5. Voltage, kVA, connections, and other special requirements shall be as indicated on the Drawings.
6. Primary and secondary winding coils shall be made of conductors, both individually cast in metal molds under vacuum to form rigid tubular coils. The 185 degrees centigrade rated, cast epoxy resin insulation shall be utilized to insure complete void-free encapsulation of the conductors. Around the inside diameter and outside diameter of each primary voltage and secondary voltage winding, full height sheets of fiberglass cloth and fiberglass matting shall be employed to insure maximum mechanical and short-circuit strength. The epoxy resin shall fully impregnate the windings and shall be free of voids and free of contaminants, including free of paint in the casting mixture.
   a. Shall be computer controlled in the casting mixture, shall be computer controlled in the casting, drying, and oven curing process.

b. The completed epoxy casting shall be self-fire extinguishing and fire resistant and not support combustion.
c. All joints and leads to the transformer coils shall be brazed or welded.
d. Transformer windings and lead-outs shall be insulated copper or aluminum. Current carrying bolted connections shall incorporate Belleville compression.

7. The windings shall not absorb moisture and shall be suitable for both storage and operation in adverse environments including prolonged storage in 100% humidity at temperatures ranging from -40 degree C to +40 degree C and shall be capable of being switched on immediately after storage without pre-drying.
8. Refined Cold Rolled Optimized Grain-Oriented (CRGO) electro-magnetic silicon steel fabricated transformer core (ANSI-M5 or better grade), insulated core laminations and finish to protect against corrosion and improve operational efficiencies.
   a. Shall reduce the transformer core no load loses to approximately 0.18% or less of the transformer nameplate rating.
9. Both primary and secondary windings shall be arranged coaxially around a stacked core with a maximum of three steps and with miter cut joints to assure lower no load losses and maximum cooling channels between the core and secondary coils. To insure that cooling air can freely circulate between the core and secondary coils, non-blocking or jacking of the secondary coils against the core shall be employed in obtaining suitable short circuit and mechanical strength. The coils shall be fixed in-place by epoxy cast blocks at the top and bottom only.
10. The core and coil assemblies shall be isolated from its case by sound dampening pads in order to reduce transmission or core vibration to the case and insuring low-noise transformer operation.

B. Transformer Insulation Basic Impulse Level-BIL rating.

Nominal Voltage	Primary- BIL	Secondary- BIL
12kV Class	95kV	30kV
5kV Class	60kV	30kV
2.4kV Class	60kV	30kV

BIL Rating prior to use of surge arrestors.

C. Taps (De-energized Operation)
1. Full kVA capacity primary taps shall be conveniently located at the front of the coils for accessibility.
2. Taps shall allow transformers to deliver rated kVA at any tap settings. Taps shall be two 2.5% above and three 2.5% below rated normal primary voltage.
3. When Dual Primary Voltage Windings are specified, both windings shall have Taps.
4. Interconnecting jumper wires shall be insulated for 133% of the rated voltage.

D. Sound Level
1. The sound levels (without forced air cooling sound contribution) shall be guaranteed by the Manufacturer not to exceed the following values;
   a. 151 to 300kVA - 58dB
   b. 301 to 500kVA - 60dB
   c. 501 to 700kVA - 62dB
   d. 701 to 1000kVA - 64dB
   e. 1001 to 1500kVA - 65dB
   f. 1501 to 2000kVA - 66dB
   g. 2001 to 3000kVA - 68dB

E. Transformer Impedance shall be NEMA standard but not less than indicated on the Drawings or exceed the value indicated on the Drawings by more than 15% of the indicated value.

F. Enclosure
1. For indoor applications, an air ventilated metal enclosure shall be provided. The base shall be structural steel of sufficient strength to permit jacking, rolling, and skidding in any direction. Removable panels shall be provided for access to the tap connections and for inspection and maintenance. Front and rear panels shall be provided with top and bottom ventilation openings backed with a mesh made of non-corrosive wire to provide adequate cooling airflow.

2. Outdoor application, an outdoor weather and tamper resistant air ventilated metal enclosure shall be provided. The base shall be structural steel of sufficient strength to permit jacking, rolling, and skidding in any direction. Front and rear panels shall be provided with top and bottom weather resistant ventilation grills and rain-shields to provide adequate cooling and to prevent rain and snow from entering the enclosure.
3. Provide rodent continuous shields on the transformer bottom.

G. Tests
1. Tests shall be as those listed below and shall be defined as those existing and required by ANSI C.57 for Cast Coil Transformers.
2. The accuracy of the calibration of all instruments to be utilized during the tests shall be ascertained and recorded at the beginning of the tests.
3. The tests shall be certified.
4. Design Tests
   a. Heat run at rated voltage, conducted on one transformer of each kVA rating. The transformer to be so tested will be selected by the engineer at the time of inspection and test. The test shall incorporate 100% of rated voltage core losses at stated temperature. Certified test results of previously built similar units will be accepted in lieu of actual tests.
   b. Short circuit test - certified test results on previously built and similarly constructed units will be accepted in lieu of actual tests.
5. Production Tests
   a. Impulse test on one transformer of each kVA rating. The transformer to be so tested will be selected by the engineer at the time of inspection and test. If one unit fails the test, all other units shall be tested.
   b. Power frequency test at two times insulation system rated voltage.
   c. Resistance measurement for each winding on the rated voltage connections prorated to the reference. Date sheets shall indicate resistance of each individual coil.
   d. Turns Ratio at rated voltage connection and on all taps.
   e. Polarity and phase rotation on the rated voltage connection.
   f. Excitation loss at rated voltage and 110% rated voltage.
   g. Excitation current at rated voltage and 110% rated voltage.
   h. Impedance and losses (no load and full load).
   i. Applied potential.
   j. Induced potential.
   k. Partial discharge test shall be performed on each fully assembled unit. All transformers shall be partial discharge tested with less than 10 pico - coulombs detected at 150% of primary voltage for 30 seconds and then 1.1 times the rated primary voltage for 3-minutes. All tests to be performed at highest voltage tap.
6. Six copies of Manufacturer Certified Test results shall be furnished to the Owner's Representative.

H. Shields
1. Electrostatic Shield: Provide full width, copper, and 100% electrostatic shield, between primary and secondary transformer windings, on each transformer phase. Shields shall be low inductance/impedance grounded to the transformer metal frame and shall attenuate common mode and transverse mode electrical noise.
2. Transformers shall be rated K4, in accordance with IEEE-C57.110.

I. The Transformer Assembly, Transformer Core, and Coil shall be earth quake restrained for the install location Earth Quake Seismic CBC/IBC rated.

2.7 TRANSFORMER SECTION (LIQUID FILLED)

A. General
1. A three phase, 60Hz AC, two winding, liquid filled transformer shall be provided as part of the unit substation assembly. Transformers shall comply with NEMA TR-1 and TP-1 latest revisions.
2. Core and coil shall be immersed in insulating liquid fluid. The transformer self-cooled Outside Air (OA) dual rating shall be 55/65 centigrade rise. The transformer shall be rated for a 12%

continuous additional overload capacity at rated voltage without exceeding 65 degree centigrade winding temperature rise. The transformer temperature rise rating shall be in 40 degrees ambient, with an average ambient for any 14-hour period of 30 degrees C.

3. Transformer assembly, transformer core and coil shall be earthquake restrained for the installation location earthquake seismic CBC/IBC rated.
4. Refined Cold Rolled Optimized Grain-Oriented (CRGO) electro-magnetic silicon steel fabricated transformer core (ANSI-M5 or better grade), insulated core laminations and finish to protect against corrosion and improve transformer operational efficiencies.
   a. Shall reduce the transformer core no load loses to approximately 0.18% or less of the transformer nameplate rating.

B. Transformer Efficiency shall meet or exceed NEMA-TP1 (latest revision) requirements, Class-1 efficiency levels and shall be marked as energy efficient for United States Department of Energy DOE/EPA “Energy-Star” Certification.

C. Less-Flammable Transformer Liquids:
   1. NFPA 70, FM P7825/3990 and UL-EOVK/EOUV listed for less-flammable liquids. Fire point not less than 360 degrees centigrade and flash-point not less than 330 degrees centigrade, testing in accordance with ASTM D92. Dielectric strength not less than 33kV tested in accordance with ASTM D877. Shall be fully miscible with mineral based fluids.
   2. Transformer liquid fluids shall be biodegradable, non-toxic, non-bio accumulating, non-mutagenic; produce no EPRI (Furhns); produce no formal decides; produce no PCDD (Dioxins). Renewable resource based transformer insulating fluid. Shall be non-contaminating during electrical load break operations and energizing switching operations, occurring with switching devices and/or fuses immersed inside the transformer fluid.
   3. Do not provide transformer liquids including mackerel and insulating liquids containing Polychlorinated Biphenyl’s (PCB's), tetrachloroethylene (perchloroethylene), chlorine compounds, or halogenated compounds.
   4. Shall be compatible with transformer insulation, gaskets and seals. Envirotemp-FR3 transformer fluid.

D. Transformer Impedance shall be NEMA standard but not be less than indicated on the Drawings or exceed the value indicated on the Drawings by more than 15% of the indicated value.

E. The Transformer Tank shall be completely welded, sealed metal tank construction. Gas space shall be provided in the tank to limit internal pressure due to normal load cycle operation, minimum 7.0 PSI. The transformer tank shall withstand not less than 15PSI positive internal pressure and 5PSI negative internal pressure without leaking or rupture.

F. Taps (De-Energized Operation):
   1. Tap changer external transformer tank operation, manual handle operator.
   2. Full kVA capacity external primary manual tap changer shall provide two 2.5% above normal three 2.5% below normal, voltage adjustments. Tap changer handle shall be pad-lockable.
   3. When dual primary voltage windings are specified, both windings shall have taps.

G. Porcelain Insulated Connector Bushing Connectors shall be provided on the line and load sides (opposite sides) of the transformer tank.

H. Transformer Throat Flanges to Enclose the Connector Bushings shall be provided on the line and load side of the transformer tank. The flanges shall provide connection to the incoming line and outgoing equipment sections.

I. The Following Transformer Components shall be provided.
   1. Combination drain and sampling valve.
   2. 1-inch top filter press connection.
   3. Pressure test connection.
   4. Dial type transformer winding temperature gauge, with resettable peak indicating pointer, “high-temp” alarm contacts and on-off relay for stop-start cooling fan operation.
   5. Liquid level gauge.
   6. Lifting jacking, skidding provisions.
   7. Ground pad.

8. Handhole on cover, gasketed and bolted connections.
9. Pressure/vacuum gauge.
10. Pressure relief device for positive over pressure and negative under pressure automatic protection.
11. Instruction nameplate.
12. Continuous welded tank cover.
13. Provisions for forced air fan cooling.

J. Cooling
1. Transformer cooling fins shall be welded to the transformer tank.
2. Transformer shall be Class OA (Liquid Immersed Outside Air) self-cooling below 300kVA and Class OA/FA (forced air fan) for 300kVA and above.
   a. The (OA) self-cooling kVA rating, primary and secondary voltage ratings shall be as shown on the Drawings.
   b. Provide Automatic Forced Air fan cooling (OA/FA) to increase the transformer capacity to not less than 120% of the self-cooling (OA) rating.
   c. All unit substation sections and bus capacity shall be increased to equal or exceed the forced air fan cooling transformer rating.

K. Transformer insulation Basic Impulse Level-BIL rating.

Nominal Voltage	Primary- BIL	Secondary- BIL
12kV Class	95kV	30kV
5kV Class	60kV	30kV
2.4kV Class	60kV	30kV

BIL Rating prior to use of surge arrestors.

L. Transformer Windings and Lead-outs shall be insulated copper or aluminum. Current carrying bolted connections shall incorporate Belleville compression washers.

M. Electrostatic Shield: Provide full width, copper, and 100% electrostatic shield, between primary and secondary transformer windings, on each transformer phase. Shields shall be low impedance/ inductance grounded to the transformer metal frame and shall attenuate common mode and transverse mode electrical noise.

N. Transformers shall be rated K4, in accordance with IEEE-C57.110.

2.8 OUTGOING SECONDARY SECTIONS

A. General
1. The outgoing section shall terminate the outgoing feeder cables and contain the Main, Tie and Feeder circuit protective devices, metering equipment, and auxiliary components described herein and on the Drawings.
2. Conduit entrance area for secondary-voltage feeder cables shall be provided in the top and bottom of the sections. The presence of conduit and cable feeders shall not interfere with proper equipment ventilation or with access to the transformer for inspection and maintenance.
3. Outgoing section devices and equipment short circuit “bolted” fault current withstand and interrupt rating shall equal or exceed the available secondary short circuit current let-thru of the unit substation transformer, plus a 25% additional safety factor.

B. Circuit Breakers
1. General
   a. Circuit protective devices as indicated on the Drawings. All devices shall have a short circuit interrupting capacity not less than the maximum bolted fault available fault current let-thru from the unit substation transformer secondary at the circuit breaker and as indicated on the Drawings, plus a 25% additional capacity (safety margin). However, in no case shall the circuit breaker interrupting capacity be less than 30,000 ampere symmetrical interrupting for 480/277 volt devices and 42,000 ampere symmetrical for 240 volt or 208/ 120 volt devices.

b. Provide padlock-off devices on each device. Breakers shall provide automatic time over-current and instantaneous circuit protection. Shall be suitable for use as “Main” service disconnect, “Feeder” and “Branch-Circuit” functions.
c. Circuit breakers shall employ a self-powered stored energy, quick make-quick break, and trip free operating system on each phase, with common trip. Circuit breakers shall not trip in the event of short term or long term electrical power failure. Dead front cover accessible close-open controls, monitors and visual indicator flags.
d. Circuit breakers noted as "100%" on the Drawings shall be tested and rated to carry the breaker full rated (100%) ampere load continuously including the assemblies the circuit breakers are installed into.
e. Provide conductor lugs for circuit protection devices to accept conductor temperature rating, sizes and quantities shown on Drawings. Circuit protection devices shall be UL-listed suitable for normal and reverse feed.
f. Provide auxiliary contacts on circuit breakers. Auxiliary “DRY” contacts shall provide supervised remote monitoring of “Open-Close-Trip” circuit breaker status. Typical for circuit breakers supplying the following types of connected electrical loads.
    1) Fire alarm equipment and devices.
    2) Mass-evacuation equipment and devices.
    3) HVAC smoke control and smoke evacuation equipment.
    4) HVAC fire/smoke electrically operated dampers.
    5) Intrusion detection and access control equipment and devices.
    6) Elevators and escalators.
    7) Fire sprinkler pumps.
g. Plug-in communications port for circuit breaker portable test instrument connects.

2. Circuit breaker data monitoring and communications:
    a. The circuit protection devices shall monitor, communicate and report circuit voltage, ampere, power, and harmonic parameters for the respective connected circuit. The circuit protection device monitor and communication parameters shall be the same and compatible with the specified “METERING” devices.
    b. Additionally the circuit protection devices shall monitor and communicate the respective device status as follows:
        1) Open/close/trip device status
        2) Ground fault trip status (where applicable)
    c. Provide circuit breaker data monitoring and communications for each of the individual feeder protection devices and main protection devices located in switchgear and switchboards, rated 400 ampere or greater trip rating.
    d. Monitoring shall also connect to transformer gauges, alarms and control panel.
        1) Temperature/fan control panel.
        2) Internal pressure and liquid level for liquid filled transformer.
    e. The respective “METER” display selection control functions shall provide selection and display of all information monitored and communicated by individual protection devices on the respective meter alphanumeric display.

3. Circuit breakers shall be Power Circuit Breaker type, Insulated Case Circuit Breaker type or Molded Case Circuit Breaker type. Time/current and instantaneous characteristics and selection of circuit breaker type shall comply with the recommendations in the Coordination Study and insure optimal code mandated time/current and instantaneous coordinated sequential tripping throughout the electrical system.
   The Contract Document intent requires providing the selection and use of the circuit breaker types and performance characteristics for time/current and instantaneous trip coordination during electrical circuit overload conditions and during electrical short circuit fault conditions. Combined with the specified circuit breaker protection time/current performance characteristics.
    a. Power Circuit Breaker type-PCB:
        1) UL-1066, comply with latest revision.
        2) NEMA-SG3, comply with latest revision.
        3) ANSI-C37.13, C37.16, C37.17, C37.50, comply with latest revision.
        4) 5Hz AC closing and up to 30Hz AC withstand duration delay trip and clear.
        5) Enclosed housing accessible for internal visual inspection, maintenance, repairs, and parts replacement.
        6) Extended function on-off instantaneous trip selection.

7) Push-to-trip button.
8) Mechanical operations counter.

b. Insulated Case Circuit Breaker type-ICCB:
1) NEMA-AB1 and AB3, comply with latest revision.
2) UL-1087, UL-489 and IEC-60.947 comply with latest revision.
3) 5Hz AC closing and 3Hz AC trip and clear.
4) Hybrid combination of MCCB type and PCB type circuit breakers with enclosed insulated housing and limited internal maintenance access.
5) Two-step stored energy close mechanism.
6) Extended function on-off instantaneous trip selection.
7) Push-to-trip button.
8) Mechanical operations counter.

c. Molded Case Circuit Breaker type – MCCB:
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) Sealed enclosed housing.

Molded Case Breakers	Insulated Case Breakers	Current Limited Breakers	Power Circuit Breakers	Fused Circuit Breakers
Molded plastic case, 80% or 100% rated in larger sizes, interrupting duties from 10 to 100kAIC; commonly used for residential and most branch circuit applications, also used in retail and commercial switchboards	Class reinforced case, 80% or 100% rated from 100 to 4,000 amps; interrupting duties from 42 to 150kAIC, solid-state digital tripping; typical uses are in commercial and light industrial applications	Generally molded or insulated case breakers, interrupting duties form 10 to 200kAIC, trip sizes from 15 through 600 amps, 80% rated	Rigid, open metal frame for longer life, 100% rated, interrupting duties from 42 to 100kAIC, trip ranges from 200 to 5,000 amps drawout only; 800 amp smallest frame size; reusable after fully rated fault interruptions	Interrupting duty of 200kAIC, generally molded case breaker 80% or 100% rated
Smaller size, lowest in cost group mounting only; group mount, individual mount, or drawn-out; frame sizes from 15 amp thru 5000 amp	Fiberglass reinforced case fully adjustable; limited short time rating; group mount, individual mount or drawout; 800 amp smallest frame size.	Inherently current-limiting both for themselves and for downstream devices; same case size as molded case breakers; digital, adjustable trip unit; group mount, or individual mount	Fully adjustable, microprocessor trip unit; may be fully repaired, maintained and adjusted; expected life on the order of 40 to 50 yrs; depending on usage and maintenance, short time rating allows better coordination with downstream equipment; individual mount or drawout	High interrupting duty, small size for maximum interrupting duty; fuses must be replaced each time it trips; group mount, individual mount or drawout
Cannot be maintained or repaired; limited adjustability without selecting operational tripping unit; useful life in the 10 to 20yr range; may not be operational after a fully rated fault interruption	Cannot be maintained or repaired; useful life from 20 to 25yrs; may not be operational after a fully rated fault interruption; solid-state electronic/digital trip	Same disadvantages as other molded case breakers; solid-state electronic/digital trip	Large size, highest cost breaker; rear access required all sizes; solid-state electronic/ digital trip. Can be fully maintained and repaired or rebuilt. +40yrs useful life.	Protects only selected downstream lower rated over-current devices; solid-state electronic/digital trip
Thermal/magnetic or electronic trip unit	May be electrically opened or closed		May be electrical open or closed	
Ground fault circuit interrupting; arc-fault interrupting, heating/refrigeration rating DC rating	Ground fault circuit interrupting; arc-fault interrupting, heating/refrigeration rating DC rating		Every possible option is available; electronic/ solid-state only tripping	Same concept can be found on power air circuit breakers

4. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
- 600 Ampere or larger frame size.
- Larger than 400 Ampere trip.
- Service entrance in main switchboard or switchgear.
- Noted as Main or Main Circuit breakers on the Drawings.

a. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Three phase or single-phase operation as noted on the Drawings. Current carrying components shall be completely isolated from the static trip units. The trip unit shall be independent of external power sources. Circuit breakers shall be rated for reverse connection.

b. Circuit breaker solid state digital trip control functions shall provide the following time/ current curve shaping field adjustable features;
   1) Adjustable ampere setting to vary the long-time continuous current carrying capacity, minimum range of 80% through 100% of full load trip rating.
   2) Adjustable long-time delay setting to vary the time the breaker will trip under sustained overload conditions. Minimum of three settings, "minimum - intermediate - maximum".
   3) Adjustable short-time pickup to vary the level of high current the breaker can carry for short periods of time, minimum range of 2 times through 8 times of ampere setting.
   4) Adjustable short time delay to vary the time of the short-time pickup. Minimum of three settings "minimum-intermediate-maximum".
   5) Short time "I^2t" switch to allow a current-squared multiplied by time ramp function in the short-time system. Two position setting "in-out".
   6) Adjustable instantaneous pickup to vary the breaker ampere setting for immediate (instantaneous) interruption of severe overloads (short circuits). Adjustable minimum range of 2.0 times thru 9 times of circuit breaker ampere sensor rating. Instantaneous selective override trip setting shall also include “on-off” function. When “off”, or “override” is selected, shall then function with the adjustable short time delay and adjustable short time pick-up (note where the coordination study requires a higher instantaneous setting, change the specified adjustable instantaneous trip to fixed instantaneous trip at 15 times the breaker ampere sensor setting also with on-off function).
   7) Individual fault trip indicators (flags) shall provide local indication on the breaker for overload and short circuit (and ground fault where applicable) conditions.
   8) Provide quantity of one, Manufacturer’s standard test set for solid state trip circuit breakers.

5. Protection performance requirements for circuit breakers conforming to one or more of the following applications:
   - Smaller than 600 ampere frame size.
   - 400 ampere and smaller trip.
   - Larger than 100 ampere frame size.
   - Larger than 100 ampere trip.

   a. Circuit breaker shall employ current sensors and solid-state static digital electronic automatic trip system. Time/current curve shaping field adjustable features
   b. Solid state digital trip breakers shall conform to the requirements described above for solid state breakers larger than 400 ampere trip. However, only the following field adjustments are required;
      1) Long-time ampere setting adjustable minimum range of 80% through 100% of full load trip rating.
      2) Short time pickup adjustable minimum range of 2 times through 8 times of the ampere setting.
      3) Fixed or field adjustable instantaneous trip (depending on the results of the Coordination Study).
6. Performance requirements for circuit breakers conforming to the following applications:
   - 100 ampere frame size and smaller.
   - 100 ampere and smaller trip.

   a. Circuit breaker shall be fixed or adjustable instantaneous current trip with thermal-magnetic trip or with solid-state static digital electronic automatic time/over current automatic trip (depending on the results of the Coordination Study).
7. Current Limiting Circuit Breakers (CLCB)
   a. Protection performance requirements for circuit breakers conforming to the following applications:
      - 600 ampere and smaller trip and identified as Current Limiting (CLCB) in the Contract Documents.

      1) Current limiting circuit breakers shall be supplied in integral fully enclosed insulating housing construction and shall consist of a common trip, thermal-magnetic or solid state static digital trip conventional circuit breaker (depending on the results of the Coordination Study), with an independently operating limiter section in series with each pole.

2) The conventional breaker section shall have an over center, trip-free, toggle-type mechanism with quick-make, quick-break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The Current Limiting Breaker shall have permanent trip units containing solid state static digital trip or individual thermal and magnetic trip elements, in each pole. Calibrated for 40 degrees C ambient temperature. The limiter section shall consist of current limiting elements on each phase, electrically coordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall be electro-magnetically and electrodynamically opened and held open until interruption is complete.
3) Current and Energy Limitations: On high-level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into the faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at near unity power factor. The Let-through short circuit fault current and energy levels shall be less than that permitted by Underwriters Laboratories to a value less than I^2t of a half cycle wave of the symmetrical prospective current. The CLCB limiter shall limit the asymmetrical short circuit fault current below the equipment symmetrical short circuit fault current.
4) On fault currents below the threshold of current limitation, the normal non-limiter breaker section shall provide conventional time/ current overload and short circuit fault protection.

b. Protection performance requirements for circuit breakers conforming to the following applications:
- Trip ratings over 600 amperes through 5000 ampere or less. Identified as current limiting (CLCB) in the Contract Documents.

1) Integrally fused circuit breaker integrated with solid state static digital electronic automatic trip. Combined standard circuit breaker providing overload-short circuit protection within its interrupting capacity and ON-OFF switching function and on each phase current limiters internally mounted on the load side of the circuit breaker of such ratings that their time current limiting characteristics will coordinate with the time current tripping characteristics of the circuit breaker elements.
2) The coordination shall result in the interruption by the circuit breaker alone of fault level currents up to the interrupting capacity of the circuit breaker and interruption by the current limiter in conjunction with the circuit breaker of fault level currents above the interrupting capacity of the circuit breaker.
3) A removable cover shall be provided over the current limiter section of the integrally fused circuit breaker. The current limiter housing covers shall be interlocked with the breaker tripping mechanism to insure the breaker will trip upon removal of the cover. The cover shall be interlocked with the breaker to insure the circuit breaker cannot be turned to the ON position with the cover removed. Current limiters shall have a spring loaded plunger which, when the limiter blows, is released to actuate the circuit breaker common trip bar mechanism opening all breaker poles simultaneously.
4) The limiters shall be individually interlocked with the breaker element tripping mechanism to insure the limiter cannot be inserted until the breaker is in the OFF position. The circuit breaker and limiters shall be interlocked to insure the circuit breaker cannot be closed if a limiter is either missing or has blown.
5) Fuse limiters shall be individually removable from the molded case housing.
6) The circuit breaker shall be ambient temperature compensating. The circuit breaker shall be provided with thermal magnetic or solid state static digital trip (depending on the Coordination Study).
7) The integrally fused circuit breaker shall be capable of interrupting available short circuit currents up to 200,000 RMS symmetrical amperes at voltage up to 600 VAC.
8) Ratings, clearances, and performance of the integrally fused circuit breaker shall be in accordance with applicable standards of NEMA, IEEE, and UL.

C. Switch and Fuse Feeder Protective Devices

1. 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 ampere at 240 volts shall be twins mounted. Switches rated through 60 amperes and 480 volts shall be

twins mounted. Switches shall be removable from front of switchboard without disturbing adjacent units or switchboard bus structure.
2. 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 switchboard.
3. 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.

D. Ground Fault Protective System as follows:
1. One control power transformer rated 480/120 volts of suitable capacity for shunt tripping of the main circuit breaker and subfeed circuit breakers as indicated on the Drawings. Fuse transformer on the 480-volt side.
2. Ground sensor current transformer for each indicated ground fault relay, zero sequence type with integral test winding for each circuit indicated on Drawings (the three phases and neutral conductor shall be brought through the current transformer window per Manufacturer's recommendations).
3. One ground break, solid-state relay, and monitor and test panel for each device indicated on the Drawings. Pick-up adjustment shall be continuous 100 through 1200 ampere; time adjustment shall be continuous from instantaneous through 60-cycles. Monitor panel shall indicate relay operation and provide means for system testing with or without interruption of service, and shall not permit system to be inadvertently left in an inactive or off state. Provide re-settable trip indicators.
    a. Ground fault system shall provide selective trip coordination with other upstream/down-stream ground fault and phase over current circuit protection devices as determined by the Coordination Study.
        1) Ground fault protection devices shall incorporate adjustable time/current trip settings.
        2) Ground fault protection devices shall incorporate adjustable inverse time and very inverse time adjustable/selective settings.
4. Zone Selective
    a. Ground fault System shall be zone selective interlock type.
    b. The farthest, downstream ground fault relay zone, sensing a ground fault, shall block all upstream relay zones for their present time delay, but shall allow each upstream relay zone to trip instantaneously for ground faults sensed in its own zone.
5. The ground fault system may be integrated into each circuit breaker with solid state trip units, in lieu of the separate specified ground fault relay and monitor panel system. The solid state circuit breaker ground fault system shall provide the identical specified operational features of the described separate system.
6. Each circuit breaker 100 ampere and larger, located in the main switchboard(s) and distribution switchboard or main switchgear where the main bus is larger than 800 ampere and operating above 240 volt phase-to-phase, shall be provided with ground fault system whether or not shown on the Drawings. Provide all interconnecting control power and interlocking wire in switchboards/switchgear and between switchboards/switchgear for an operational system.

E. Secondary Switchboard Outgoing Sections
1. Switchboard shall be floor-mounted, dead-front, dead-rear type, front and rear aligned, self-supporting, consisting of one or more vertical sections with bussing, circuit protective devices, instrumentation, auxiliary devices and control wiring as indicated on the Drawings and as specified herein. Close-coupled to the unit substation transformer.
    a. Unit substations located indoors shall be service entrance rated and approved.
    b. Switchboards shall employ mounting configuration for circuit protective devices as follows:
        1) Group-mount, fixed position, non-drawout switchboards. Front access only, shall not require rear access. Typical for all circuit protective devices, or as indicated on Drawings.
        2) Individual-mount, fixed position, non-drawout employing individual "cells", rear-accessible load circuit connects switchgear. Typical for all circuit protective devices, or as indicated on Drawings.
        3) Individual-mount with horizontal drawout, employing individual "cells", rear-accessible load circuit connects switchgear. Typical for all circuit protective devices, or as indicated on Drawings.

c. Switchboards shall employ circuit breakers types and circuit protection devices as follows:
   1) All Main circuit breaker of all frame sizes – ICCB type circuit breakers.
   2) 800 ampere and larger frame size Feeder circuit breakers, ICCB type circuit breaker.
   3) Smaller than 800-ampere frame size Feeder circuit breakers, ICCB type; or MCCB type circuit breakers.
   4) CLCB type circuit breakers. CLCB circuit type only where noted on the Drawings.
   5) CLF with switch and fuse type. CLF with switch and fuse type only where noted on the Drawings.

2. Switchboard shall be designed, built and tested in accordance with applicable portion of the latest editions of NEMA PB-2, Underwriters Laboratories No. UL-891 and the National Electrical Code. Rated for service-entrance operation.
3. Switchboard sections configuration
   a. Floor standing self-supporting, of the universal frame type using die-formed, 12-gauge steel members bolted and welded together.
   b. Provide removable side and rear plates with formed edges all around.
   c. Provide ventilation openings required for maintaining nominal operating temperature.
   d. Provide removable steel cover plates for all usable device spaces. Provide lifting means and provisions for moving by means of rollers or skids to installation location.
   e. Bolt individual sections together to form a single rigid switchboard assembly.
   f. Provide full height, hinged, vertical wireway metal covers, on each vertical wireway, of each distribution section of the switchboard.
   g. Typical for all switchboards, distribution switchboards and switchgear.
4. Switchboard shall include, but not be limited to, the following:
   a. Current transformer space.
   b. Main disconnects devices.
   c. Distribution and feeder circuit protective devices.
   d. Owner metering
   e. Bussing, incoming from transformer and outgoing distribution.
   f. Transient Voltages Surge Suppressor Protection – (TVSS).
5. Switchgear Outgoing Sections
   a. Additional requirements for switchgear configuration (in addition to the requirements described for Switchboard configuration).
   b. Each circuit protective device shall be individually metal enclosed cells, isolated from all other circuit protective devices.
   c. “Main” and “Tie” and “Feeder” circuit protective devices shall be individual-mount horizontal drawout rear connected load lugs. Feeder load connections shall be completely isolated from all other “energized” line side bussing.
   d. “Main” and "FEEDER" and “Tie” circuit protective devices shall be individual mount, horizontal drawout, with automatic dead-front shutter devices, protection devices position indication switches, lifting bars, control power source, racking tool, shunt trip with auto charge capacitor trip, electrical “on-off” remote control with electric “charging” closing-motor and secondary control disconnects.
      1) Provide four position racking of circuit protection devices, “connected-test-disconnected-remove”. Mechanical and electrical interlock Racking position with visible indicators on the front access doors. Provide electric motor operated "racking-unracking" with remote control functions. Shall reduce exposure of Operating Personnel to ARC-FLASH risk during device operation faults. Provide remote control portable operation controller.
      2) Remote “open-close” electric operation of each circuit protection device, typical for “Main”, “Feeders” and “Tie”.
      3) Provide a "Dolly", traveling portable lift and transport device for drawout devices. Dolly shall include remote electric motor operation for device racking-unracking insert/ withdraw operations. Shall reduce exposure to ARC-FLASH risk during device insertion and removal.
      4) In addition to the protection requirements described elsewhere for circuit protection devices, provide loss of phase voltage and reverse power flow (Phase A, Phase B, and Phase C) detection relays with auxiliary relay contacts for each “Main” device).
      5) “Main” and “Tie” circuit protection devices shall be electrically and mechanically interchangeable with each other.

6) Provide electrical and mechanical interlocks on “Main” and “Tie” circuit protection devices. The interlocks shall prevent all parallel “closed” operation of “Main” devices through the “Tie” devices.

e. Circuit protective devices both fixed individual-mount and horizontal-drawout types, shall be electric motor operated remote control "on-off" for open/close functions. Shall reduce exposure of Operating Personnel to ARC-FLASH risk during device operation faults. Provide remote control portable operation controller, with not less than 25 foot portable plug-in length for operator with controller and cable.

f. Metalized individual compartmentalized and metal barrierd segregated construction:
   1) Segregated individual front accessible each circuit protection device cell.
   2) Segregated between incoming and outgoing cable compartments, rear field accessible.
   3) Segregated horizontal main bus and riser bus. Field removable maintenance access covers for connects hardware.
   4) Dead front automatic plug-in shutters and pad-locking devices for each “racking” operation.

g. Switchgear shall employ circuit breaker types and circuit protection devices as follows:
   1) All Main circuit breakers and Tie circuit breakers – PCB type circuit breakers.
   2) 800 ampere and larger frame size Feeder circuit breakers – PCB type circuit breakers.
   3) Smaller than 800 ampere frame Feeder circuit breakers – PCB type; or ICCB type; or MCCB type circuit breakers.

h. Switchgear shall be designed, built, tested, listed and labeled in accordance with applicable portion of the latest editions of NEMA, Underwriters Laboratories and the National Electrical Code (NEC), including but not limited to:
   1) Switchgear as follows

Standard	Description
ANSI C37.20.1	Metal-enclosed low voltage circuit breaker switchgear.
ANSI C.37.51	Testing of metal-enclosed low voltage AC circuit breaker switchgear
NEMA SG-5	Power switchgear assemblies
CAN/CSA C22.2 No. 31-M89	Switchgear assemblies
ICC/IBC and CBC	Local seismic requirements.
UL 1558	Switchgear assemblies

   2) Main and feeder and tie circuit breakers in switchgear shall be designed, tested, manufactured, listed and labeled including but not limited to:

Standard	Description
ANSI C37.13	Low voltage AC power circuit breaker used in equipment.
ANSI C37.16	Preferred rating, related requirement and application recommendations for low voltage power circuit breakers and AC power circuit breakers.
ANSI C37.17	Trip devices for AC and general-purpose dc low voltage power circuit breakers.
ANSI C37.50	Testing of low voltage AC circuit breakers.
NEMA SG-3	Low voltage circuit breakers.
UL 1066	Low voltage circuit breakers.

F. Transient Voltage Surge Suppressor – TVSS
   1. Provide a 3-phase, 5-wire TVSS in the secondary outgoing section with 30ampere 3-pole subfeed circuit breaker.
   2. See Specification Section 16050 for TVSS additional requirements.

2.9 METERING (OWNER METERING)

A. General
   1. The meters shall be microprocessor controlled, digital, multi-function measuring and indicating meters. The meter measurement sensing method shall be true RMS. As manufactured by Electro Industries Model DMMS300, Square D, General Electric, Westinghouse or equal.
   2. Meter face size approximately 4.5-inches by 4.5-inches. Overall depth approximately 8.0-inches. Semi flush mounting, self-contained, dust proof, insulating electrical housing.

3. Ambient temperature operating ranges 0 degrees Centigrade to 55 degrees Centigrade.
4. The meter shall be rated to accommodate single phase and "DELTA" or "WYE" three phases, direct voltage connection up to 600 volts AC.
5. The meter shall accommodate input connection through Potential instrument Transformer (P.T.) for voltages in excess of 600 volts. Meter burden shall not exceed 6.0 volt amperes.
6. The meter shall be rated to accommodate input connection through instrument Current Transformer (C.T.) up to 12,000 amperes, with a secondary C.T. current up to 10 ampere.
7. The meter scales shall be field programmable for any C.T. and P.T. ratios.
8. Provide a meter on the secondary side of the unit's substation and as indicated on the Drawings.

B. Meter Indications

1. Meter indications shall be alphanumeric, LED display type, and 0.56-inch minimum character height. Meter indications shall simultaneously display the numerical value(s) being measured and the name of the measured value (i.e. "1586329 TOT. KWH" etc.). Meter display update time 1-second.
2. Minimum meter display operating life shall be 100,000 hours.
3. Meter withstand ratings:
   a. Continuous 200% of rating.
   b. Surge 10 times rating for 3 seconds.

C. Meter Monitoring and Measurement Range

1. The meter shall provide multi-function monitoring for all combinations of phase to phase and each phase to neutral of the following parameters in a single self-contained digital meter unit;

Measurement Indication	Accuracy	Resolution	Range
Kilowatts	0.5%	0.1%	0 to 1,000,000
Kilowatt Hours	0.5%	1kW Hr	0 to 1,000,000,000
Kilowatts Max-Min Demand	0.5%	0.1%	0 to 1,000,000
Kilovolt Ampere Hours	0.5%	1kVA Hr	0 to 1,000,000,000
Kilovolt Ampere Reactive	0.5%	0.1%	0 to 1,000,000
Kilovolt Amperes	0.5%	0.1%	0 to 1,000,000
Power Factor	1.0	1.0%	1.0 to + 0.5
Ampere	0.35%	0.1%	0 to 10,000
Volts	0.35%	0.1%	0 to 100,000
Frequency	0.02Hz	0.01Hz	10Hz to 125Hz
Total Harmonic Distortion Current & Voltage Input to 31st Harmonic.	0.5%	0.2%	0 to 100%

2. The measurement indications shall display continuously in sequence; by individual continuous measurement; or no display (display-off) when programmed from the meter front control panel.
3. The minimum and maximum average time range shall be adjustable from instantaneous through 9999 seconds. The average time range shall be programmable from the meter front control panel to provide an instantaneous and average over time of any meter measurement indication, in any combination of measurement indications.
4. The minimum and maximum for each measurement indication shall be stored in internal memory and displayed on the alphanumeric meter display when requested from the meter control panel by the Operator.
5. The meter shall store in non-volatile internal memory the following information. The stored data shall be retained even during a power failure to the meter. The information shall be recalled to the meter display from the meter front control panel:
   a. Meter preset program parameters.
   b. Maximum and minimum measurement indications.
   c. Total kilowatt-hours.
   d. Total kilovolt ampere-hours.
   e. Kilowatt demand.

D. Meter Programming and Control

1. A control panel on the front of the meter shall provide user access to all meter displays, functions and programming features. A password protection entered from the front control panel shall be provided prior to allowing any programming or set point changes to the meter.

2. The meter shall provide “data logging”; monitoring and communications for each respective circuit breaker located the same equipment at the meter. The meter shall also provide password-protected software programming of circuit breaker operating parameters, and monitoring characteristics.

E. Communications Ports and Protocols Meter Connection.
   1. EIA serial port RS-485.
   2. IEEE-Fast Ethernet RJ-45 port.

2.10 MISCELLANEOUS INSTRUMENTS

A. Instrument and Control Transformers: ANSI C57.13 and NEMA ST20 as applicable. Transformers shall be specifically designed for use on respective protective relay or metering schemes utilized.

B. Current transformers meter/relay grade shall be multi-ratio tap, tap setting as indicated on Drawings, (minimum of three field adjustable tap settings) with 5-amp secondary, insulation class, 600 volt, 60Hz, single ring type, and shall have an accuracy Classification of 0.3 with the burden of B.01, B.02 and B.03.

C. Control and transfer switches shall be of the rotary, oil-tight multi-position, cam-operated, multi-stage type, with dust cover and silver-to-silver contacts rated 600 volts, 20amp and adequate for the duty performed in excess of 10amp. Equip each switch with engraved plastic escutcheon nameplate identifying its function and position.

2.11 CONTROL WIRING

A. Terminal blocks with barriered terminals for each connection shall be provided for all control wiring terminator points. Control wiring shall be run in horizontal and vertical, isolated, internal metal wireways and shall be carried across hinges in laced bundles. Wire terminators shall be crimp-on type spade terminal

B. Secondary control wiring shall be a minimum of 14 AWG stranded copper type SIS 600-volt insulation.

C. Control circuits shall have circuit number tags at each termination or break in the wire to match circuit numbers on terminal strips and control wiring diagrams.

2.12 MISCELLANEOUS

Provide painted signs on housing doors, minimum 3-inch letters: "WARNING HIGH VOLTAGE AUTHORIZED PERSONNEL ONLY".

2.13 FORCED-AIR COOLING EQUIPMENT:

A. General:
   1. Provide transformer forced air, fan cooling for unit substation transformers 300kVA and larger. The equipment shall consist of cooling fans, temperature-sensing devices, and controls, complete with housing, mounting devices, and wiring. Operation of the cooling fans shall be automatically controlled by temperature-sensing devices. Connect a manually-operable switch in parallel with the automatic control contacts. Enclose the controls in a cabinet located on the side of the transformer or mount the temperature control module on the front panel of the transformer enclosure at a height not greater than 60 inches above.
   2. Cooling fans shall increase the unit substation transformer and outgoing secondary load capacity an additional amount as follows:
      a. Dry type transformers, 30% increase.
      b. Cast coil transformers, 15% increase.
      c. Liquid filled transformers, 15% increase.

B. Operation

1. Cooling Fans: Motors shall be rated for the same voltage as secondary winding or an auxiliary power transformer shall be furnished. The auxiliary transformer shall be provided with primary and secondary over current protection. The fan motors shall be of totally enclosed fan cooled construction, 1 phase, ball bearing, continuous duty rated with 3-wing blades; direct drive blower wheels will also be accepted.
2. Temperature-Sensing Devices: Thermal sensors shall be embedded in the hot spot area of each secondary coil (a single top fluid sensor for liquid filled transformers) to provide the most precise measurement of heat rise performance.
3. Three-phase electronic temperature monitor unit accepting input from three thermal sensors. The monitor shall track the temperature of the transformer with automatic digital displays and functions controlled by the signal received from the hottest phase. Unit features shall include temperature monitoring of each transformer coil, hottest phase temperature display, temperature display of any phase, two SPST contacts for both local and remote fan control, temperature alarm, and trip functions, manual fan operation, local alarm with local and remote silence feature. Monitor unit shall be suitable for use on 120, 240, 277 volts AC, 60Hz supply power. It shall employ an automatic fan exerciser, which shall energize fans for approximately 1-minute every 6-days.

C. Transformer Temperature for Future Forced-Air Cooling Equipment:

1. Dry-Type: Winding Temperature on Class AA Transformers 300kVA and above: Shall include sensors directly in the air ducts of each coil to monitor coil temperature. Provide for mounting of cooling fans at bottom or top of core/coils.
2. Liquid filled transformers, provide support brackets for mounting cooling fans on transformer housing and radiator-fins.
3. Provide 60Hz AC operation electrical control power connection/source and disconnect for cooling equipment.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Electrical Installation shall conform to ANSI C2, NFPA 70, and to the requirements specified herein. All equipment and materials shall be new unless indicated or specified otherwise.

B. Prior to Energizing and Testing, Manufacturer's Field Engineer shall visually inspect and verify devices are operational and bus connects complete.

3.2 ANCHORING OF EQUIPMENT

Anchoring of equipment shall be in compliance with the earthquake seismic vertical and lateral acceleration install location and CBC/IBC rated. Submit structural calculations and details.

3.3 TORQUE INTERCONNECTING BUSSING BOLTS AND ANCHOR BOLTS PER MANUFACTURER'S DIRECTIONS.

3.4 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment and switchgear, furnished under this or other Sections as indicated on Project Drawings, the Shop Drawings, and as specified herein.

3.5 FIELD TESTS, INSPECTIONS, AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. Test all equipment after the installation has been completed, and the Owner's Representative has been given 10-days' notice of the proposed tests. The Contractor shall provide operating tests demonstrating that all equipment and devices operate in accordance with the requirements of the documents.

B. Adjustable Settings

1. Shall be set and tested after the equipment installation is complete, for proper operation at set points, pickup, and/or drop-out points. Shall be performed by an independent Test Laboratory and Trained Certified Technicians actively engaged in testing and using test instruments designed and manufactured for the purpose.
2. Provide protection device settings and test, to insure operation and coordination as described in the time/current coordination final submittal, and in accordance with the Contract Documents.
3. Calibrate and testing shall comply with the Equipment Manufacturer recommendations.
4. Correct deficiencies, non-compliant equipment and retest to demonstrate compliance.
5. Submit reports to Owner's Representative, six copies.

C. Acceptance Checks and Tests: Perform in accordance with the Manufacturer's recommendations and NFPA 70B, Appendix I and ANSI C57.94. Perform work in a careful and safe manner so as not to endanger personnel or equipment. Acceptance checks and tests shall include, but not be limited to, the following:

1. Inspect devices, equipment, etc., for damage or maladjustment caused by shipment or installation.
2. Remove wedges, ties, and blocks installed by the Manufacturer to prevent damage during shipment.
3. Verify ground lugs and grounding connections.
4. Verify that the proper phase sequence in maintained.

D. See General Commissioning Requirements Section 019113 for prefunctional and functional testing requirements.

3.6 MISCELLANEOUS

A. Provide painted signs on equipment housing doors, minimum 3-inch letters "DANGER HIGH VOLTAGE, KEEP OUT, AUTHORIZED PERSONNEL ONLY".

END OF SECTION 261105
090816/1010006

SECTION 261800
INTERRUPTER AND SECTIONALIZING SWITCHES

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all transformers, device relays, anti-condensation equipment, enclosures, disconnects, fuses and meters.

B. Submit Detailed Shop Drawings including Dimensioned Plans, Elevations, Details, Schematic Single Line, Point To Point Wiring Diagrams and descriptive literature for all component parts. Submit Scaled Plans and Elevation View Drawings.

C. Submit full-scale time/current transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays.

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 current settings to provide the 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

E. Submit Transformer Test Reports

F. Factory Tests: Switchgear tests - ANSI C37.72.E Certified copies of Design Tests, Production Tests, and Conformance Tests of the switchgear shall be submitted and reviewed on the Project Site. In lieu of the above tests, a report of these tests previously performed on identical units of each rating will be acceptable.

1.3 APPLICABLE STANDARDS

The Switchgear Equipment shall be designed, tested, and assembled in accordance with the latest applicable Standards of National Electrical Code, ANSI, IEEE, and NEMA and UL.

PART 2 PRODUCTS

2.1 FUSED INSULATED LOAD INTERRUPTER SWITCHES

A. General

1. Medium voltage, metal enclosed switchgear, consisting of Current Limiting Fuses, "SF6" or "Vacuum" insulated sealed bottle, current interrupters and integral, visible air gap, isolation switch. As manufactured by McGraw Edison PCME Series or Square D. VISI-VAC Series.
2. The equipment shall be tested to ANSI C37.72.1 and other applicable Standards.
3. The completed metal-enclosed switchgear shall have the following electrical ratings:

	4160 Volt System	12000 Volt System
a. Maximum circuit voltage, to ground	5kV	15kV
b. Continuous Current	600 Amps	600 Amps
c. Impulse BIL	60kV	95kV
d. 60Hz Withstand	36kV	36kV
e. Load Break Interrupting	12,500 Amp	12,500 Amps
f. Momentary Current Without Fuses)	20,000 Amp (Asym. RMS)	20,000 Amp (Asym. RMS)
g. Momentary Current with current Limiting Fuses	40,000 Amp (Asym. RMS)	40,000 Amp (Asym. RMS)
h. Fault Closing Current	20,000 Amp (Asym. RMS)	20,000 Amp (Asym. RMS)
i. One Second Rating with Fuses	20,000 Amp (Sym. RMS)	20,000 Amp (Sym. RMS)

B. Switch Structure

1. The switch frame shall have structural anchor points permanently attached to the assembly, to provide for bolting the switch sections securely to floors and walls.
2. The Switch Manufacturer at the factory shall provide internal interconnections.
3. Switch components shall be front and rear accessible for normal maintenance. Rear access of primary incoming line conductors shall be provided. Access shall be provided for outgoing line and load conductors, top or bottom conduit entrance as indicated on the Drawings. Conduit and conductor space shall meet NEC requirements.
4. Ventilating openings (if required by the Manufacturer) in the enclosure shall be located to insure proper cooling at installed equipment at the locations shown on the Drawings. Provide expanded metal screens on vent opening. Construction shall prevent entry of rodents into the equipment interior.
5. Finish paints indoor equipment. Rust inhibitor primer with Manufacturer's standard finish color, final paint coat over primer.
6. A prominent nameplate bearing equipment ratings, Manufacturer identification, and reference serial numbers operating instructions shall be mounted on the front of the unit.
7. The equipment enclosure shall not require routing of line and load side conductors in front of the switch/fuse compartment.

C. Bussing

1. Horizontal and vertical busses shall be full lengths. Busses shall have a minimum withstand rating equal to available fault current indicated on Drawings, but in no case shall the rating be less than 400 MVA RMS symmetrical at indicated operating voltages.
2. Provide interconnected ground bus in each section.
3. Provide space, all hardware and mounting attachments for future devices as indicated on the Drawings.
4. Main horizontal bussing shall be full capacity in all equipment sections.
5. The bussing shall be of sufficient cross-sectional area to meet UL Standard 891 on temperature rise. Buss shall be copper with silver plated bus joints. The through buss shall have provisions for the addition of future sections. The through bus supports, connections and joints shall be bolted with grade 5 hex head bolts and Belleville washers to minimize maintenance requirements.

6. Primary bussing shall be fully insulated with a factory applied, extruded bus insulating material. All primary bussing shall be supported on porcelain insulators. Primary bussing BIL shall be 95kV for 15kV class and 60kV for 5kV and 2.5kV Class.

D. Conductor Terminations

1. The incoming and outgoing lines shall be provided with factory filled porcelain "slip-on" type with stress cone relief cable terminations for the incoming and outgoing feeders entering the section as indicated on the Drawings, provide support brackets on equipment frame for cable terminators. Provide 4-bolt spade lug connector, bolt to bus with grade 5 HEX head bolts and Belleville washers.
   a. BIL 110kV
   b. Current Rating same as feeder cable
   c. 1 minute dry AC test 50kV
   d. 6 hour dry, AC test 35kV
   e. 10 second wet, AC test 45kV
   f. 15 minute dry, DC test 75kV
   g. Cable diameter and type as show on Drawings.

E. Circuit Interruption

1. The switch mechanism shall be fixed mounted, load interrupting, quick-make, quick-break stored energy operating mechanisms with electrically operated shunt trip to open switch. Switches shall be 3 pole, two-position gang operated. Switches shall be designed to meet NEMA Standards for a Class A device.
2. A electrically operated, stored energy charging mechanism shall be provided, isolated form the line and load voltages and coupled to the stored energy mechanism.
3. A manually operated stored energy charging mechanism shall be provided to allow opening and closing the switch and charging the stored energy mechanism. The manual system shall be operable independent of any of other switch operating mechanism. The manual operator shall be accessible on the front of the switch housing and operable without requiring opening the switch or fuses access doors.
4. The switch operator shall provide positive identification of the switch position "open" - "closed".
5. Switch Contacts and Operation
   a. The main circuit load break arc interruption and load make shall occur with open-close moving metal contacts enclosed inside sealed, insulated envelope bottles, one per phase. The insulated bottles shall contain an insulating Vacuum or "SF6" insulating gas as the electric arc quenching medium after the moving main contacts have separated.
   b. A visible air gap, open-close moving switch blade one per phase shall be provided to isolate the load make/break contacts from the incoming line side circuit. The isolation switch shall be integral with the insulated envelope load make/break bottle mechanism or connected upstream in series with the envelope bottles.
   c. Upon initiating a switch "open" action the main load make/break contacts shall separate and open prior to the isolation switch contacts separating and opening. Upon initiating a switch "close" action the main load make/ break contacts shall make and close prior to the isolation switch contacts closing.
   d. The operation of the main load make/break contacts and the isolation switch contacts shall be fully integrated with a single operating switch mechanism. Total switch "close" or "open" operating time shall be less than 4 cycles of the 60Hz-line frequency.
5. A door mounted viewing window shall provide observation of the air isolation switch contacts.
6. Means shall be provided to padlock the switch in the open or closed position.
7. Provide lightning arrestors mounted inside the compartment, one per phase distribution type, connected between the switch and fuses.
8. Access to fuses while energized shall be positively prevented through a mechanical interlock system which keeps the fuse section front door locked closed when the switch is in the closed "energized" position.
9. A fixed internal safety barrier to prevent inadvertent contact shall guard any internal parts that remain energized with the switch contacts open by operating or maintenance personnel with the door open. Interphase insulating barriers shall be provided for the system voltage class, to isolate switch and fuse poles from each other and from grounded metal.

10. Non-expulsion current limiting fuses with a short circuit interrupting rating of 50,000 amperes RMS symmetrical shall be supplied fixed mounted on the load side of each main switch pole. The fuse continuous current rating shall be in accordance with the Manufacturer's recommendation to adequately protect the transformer from damaging overloads. Fuses shall provide a visible "Blown-fuse" indication. Fuses shall be removable from the front without special tools.
11. Provide single phasing protection, to automatically cause the switch contacts to open, in the event one or more fuses open due to overload or short circuit conditions.

F. Control Power
   1. Provide a primary fused potential transformer or control power transformers on the incoming line side of the switch provide 120 volt. 60Hz AC power to operate the stored energy charging mechanism, auto charge capacitor trip unit, and pilot lights. Fuses and transformers shall be trunnion mounted.
   2. Provide "auto-charge" capacitor trip device consisting of an automatic battery charger. Under normal conditions, with 120-volt AC control power used for the stored energy charging mechanism, a self-contained, sealed, rechargeable, nickel-cadmium battery shall be maintained at full charge by an automatic battery charger connected to the 120-volt AC source. Upon loss of AC power, a voltage amplifier shall step up the battery voltage to the higher voltage needed to maintain the circuit breaker tripping charge on the capacitor for a minimum of 2-days. The capacitor units shall provide direct current storage and tripping power for each switch.

G. Controls - shall be mounted in the front door of the switch with rear barriers to isolate the components from line and load voltages.
   1. Provide "open-close" switch pushbuttons on electrically operated switches. Provide "open" pushbutton on manually charged switches.
   2. Provide separate pilot lights with push-to-test to indicate the following conditions:
      a. Green - indicating switch in the open position.
      b. Red - indicating one or more blown fuses.
      c. Yellow - indicating the incoming line voltage is energized.
      3. Provide automatic zero sequence ground fault relay tripping of the switch.
      4. Provide current transformer and metering as indicated on Drawings.

H. Provide voltage surge arrestors, one per phase on the load side of the switch main contacts.

2.2 SECTIONALIZING SELECTOR SWITCHES

A. General
   1. Manually operated load interrupting, gas SF6, insulated switches for indoor and outdoor pad mounted enclosure application.
   2. The units shall be designed, tested, and assembled in accordance with the latest applicable Standards of ANSI-C37.71 and IEC 265.
   3. Switches as manufactured by G & W Electric Co. type RAM (two positions) or RAC (three position) as indicated on Drawings, or equal.

B. Electrical Ratings and Standards
   1. Switches shall be designed, tested and built to the following design voltage:
      a. Maximum circuit voltage to ground 15.5kV
      b. Impulse Level (BIL) 110kV
      c. 60HZ AC 1 Minute Withstand..... 34kV
      d. DC 15 Minute Withstand 53kV
      e. Continuous Current and Load Break, Interrupting .....600 Amp
      f. Momentary Current Withstand……. .....40,000 Amp (Asym. RMS)
      g. Close-and-latch fault-close capability 3time…… ..... 40,000 Amp (Asym. RMS)
      h. One Second Current Withstand ....25,000 Amp (Sym. RMS)

C. Switch Configuration
   1. Switches shall be or vertically or horizontally mounted with bottom or side conductor entrances as shown on the Drawings.

2. Each switch handle shall have three conductor entrance ways for each switched way as shown on the Drawings.
3. Each switch way shall be two positions "open-close" (RAM) or three position "close-open-close" (RAC) as indicated.

D. Switch Construction

1. Switch components and entrances shall be assembled in a single ¼-inch thick mild steel tank with entrances internally connected by copper wire ropes and bus bars capable of handling momentary and continuous current duty. The switch tank shall accept the conductor entrances listed elsewhere in this Specification without the need for field contact alignment prior to energizing.
2. Switches shall be shipped factory filled with SF6 insulating gas. Tank shall be designed to withstand 15 PSIG internal pressures and an external pressure of 14 PSIG without affecting the performance of the switch.
3. The following standard components shall be included:
   a. Filling valve.
   b. Four lifting eye provisions.
   c. Viewing windows to permit inspection of the switch contacts in the open/off position.
   d. Gas pressure gauge.
   e. Grounding provisions for one ground conductor connection per switch way plus provisions for one tank ground conductor connection.
   f. Corrosion resistant tank design using stainless steel and brass fasteners with no external aluminum parts.
   g. One line diagram and stainless steel nameplate fastened with stainless steel mechanical fasteners.
   h. Compression spring operator.
   i. Welded mild steel lids.
   j. Tank coating to be ASA 70 light gray vinyl paints three-mil thick minimum.
   k. Pad-lockable, operating mechanism with position indication.

E. Conductor Entrances

1. Entrances shall be rated 110KV BIL for 15kV and of the following:
   a. Side conductor entrance - 600 amp or 200 amp apparatus bushings, non-load break for connection of non-load break elbow, conductor connections. 200 amp for conductor sizes smaller than 4/0 AWG, 600 amp for conductor sizes 4/0 AWG and larger.
   b. Bottom conductor entrance - 600 amp three single conductor stud bushings with removable compartments filled with non-hardening insulating compound. Bushings shall be rated 40,000 amps asymmetrical momentary, 25,000 amp symmetrical short time current, 110kV BIL for horizontal mounted switch tank units.

F. Switch Operation

1. Each switching way shall be equipped with an internally mounted operating mechanism, providing quick-make, quick-break operation in either switching direction. The mechanism shall deliver sufficient torque and shall be provided with latches for each position to assure load interrupting, fault closing and momentary ratings. The mechanism shall use compression type springs to insure long life and reliability. All switch positions are to be clearly identified and pad-lockable. Pad-lockable ground stops shall be provided on switches with internal grounding capability.
2. The operating mechanism shall be actuated from outside the switch tank by a removable, breakaway handle. The operating handle shall assure operation in the proper direction and prevent rapid reversal of the switch contacts.
3. The operating shaft shall be made of stainless steel for maximum corrosion resistance. A "0" ring type operating shaft seal shall be used for a leak resistant, long life seal.

G. Switch Contacts

Switch contacts shall be plated, high-conductivity copper alloy to assure permanent low resistance and to avoid sticking during operation. The contacts shall be designed so arcing does not occur in the area of main current interchange and the contact pressure shall increase with increasing current flow. Contact travel shall be 60 degrees and have sufficient open contact separation to assure efficient arc extinction and to withstand field DC testing levels and maintain BIL levels.

Temperature rise shall not exceed ANSI C37.71 and IEC 265 standards for this type of device. Switch contacts shall be clearly visible in the open position.

H. Mounting Frames

1. For vertical switch tank mounting, frames shall be constructed of steel channels supplied as Standard, to the bottom of the switch to provide a 5-inch clearance from the floor and to allow clearance of switch operating handles above floor line and enclosure.
2. For horizontal switch tank mounting, frames shall be of sufficient height to allow bottom termination of conductors at the entrance bushings.
3. Frames and channels shall be of bolted hot dip galvanized steel construction. Galvanized enclosing panels shall be supplied for the cable entrance compartment.

I. Factory Production Tests

Bulk SF6 gas supply shall be tested for dielectric strength and moisture content. Each individual switch shall undergo a mechanical operation check and a leak test. Switch shall be factory filled with SF6 gas and AC hi-pot tested at 40kV, 1 minute phase-to-phase and phase-to-ground and across the open contacts. Circuit resistance shall be checked on all ways.

2.3 CONTROL WIRING

A. Terminal blocks with barriered terminals shall be provided for all control wiring terminator points. Control wiring shall be run in horizontal and vertical, isolated, internal metal wireways and shall be carried across hinges in laced bundles. Wire terminators shall be crimp-on type spade terminals.

B. Secondary control wiring shall be a minimum of #14 AWG stranded copper type SIS 600 volt insulation.

C. Control circuits shall have circuit number tags at each termination to match circuit numbers on terminal strips and control wiring diagrams.

2.4 PROTECTIVE RELAYS

A. General

1. Protective relays shall be semi-flush, dead-front individual case mounting, drawout construction with test and shorting blocks, extended range (induction disk operation) solid state static.
2. Relays shall incorporate visible, seal-in, externally resettable, target indicators to show trip mode (overcurrent, instantaneous as applicable).
3. Repeat operating accuracy shall be plus or minus 7.5% on time settings, plus or minus 3.5% of current pick-up settings.
4. Pick-up trip-initiating setting ranges shall be as indicated on Drawing or as determined by the Coordination Study.
5. Relays shall operate from 5 amp secondary current transformers and 120 volt secondary potential transformers within specified accuracy ranges from 0 load to maximum withstand rating of related circuit breakers. Relays shall operate with the circuit breaker control circuits. Relays shall incorporate auxiliary contacts for external device operation and shall be provided with all auxiliary devices required for complete and correct system operation.
6. Relay time current curve operating characteristics shall provide selective coordination with new and existing upstream and downstream primary protective relays and fuses. Relay settings will be furnished by the Contractor to the Engineer.
7. Provide inverse, very inverse or extremely inverse relay tripping characteristics and Manufacturers standard setting ranges as determined during Shop Drawing submittal phase and by the Coordination Study.
8. Relays shall comply with ANSI/IEEE C37.90 and C37.2.

B. Time Overcurrent Phase Relay (device type 50/51).

1. One per phase, non-directional, current-sensitive, AC device, operating time shall be inversely related to operating current.
2. Instantaneous unit shall provide relay operation with no intentional time delay for currents exceeding a predetermined level. Instantaneous trip unit shall have external jumpers to defeat the instantaneous trip element.

3. The relay shall have field adjustable time delay dial, overcurrent pick-up tap settings as multiples of current transformer ratio, instantaneous trip with tap block range adjustment.

C. Time Overcurrent Ground Relay (device Type 50N/51N).
   1. Same as phase relay type 50/51, except connected in residual current arrangement to provide protection upon phase to ground, fault.

D. If solid state type relays are utilized, provide one complete Manufacturer's Relay Testing system installed in the switchboard.

2.5 INSTRUMENT AND CONTROL TRANSFORMERS

A. General
   1. Instrument and Control Transformers: ANSI C57.13 and NEMA ST20 as applicable.
   2. Transformers shall be specifically designed for use on respective protective relay or metering schemes utilized.

B. Current Transformers
   1. Meter/relay grade, shall be multi-ratio tap, initial tap setting as indicated on the Drawings, with 5 amp secondary.
   2. Insulation class, 15,000 volt, (5000 volt) 60Hz, 95kV (60kV) B.I.L., single ring type, and shall have an accuracy classification of 0.3 with the burden of B.01, B.02 and B.03.

C. Potential Transformers
   1. Shall be for insulation class, 15,000 volt, (5000 volt) 60Hz, 95kV (60kV) BIL.
   2. Bus voltage to 120-volt ratio and shall have an accuracy classification of 0.3 at rated voltage with the burden of B.01, B.02 and B.03 connected to transformers.
   3. Potential transformers and primary fuses shall be one piece horizontal drawout construction, or Trunion mount style.

2.6 MISCELLANEOUS SWITCHGEAR DEVICES

A. Control and Transfer Switches shall be of the rotary, oil-tight multi-position, cam-operated, multi-stage type, with dust cover and silver-to-silver contacts rated 6000 volts, 20 amp and adequate for the duty performed in excess of 10 amp. Equip each switch with engraved plastic escutcheon nameplate identifying its function and position.
   1. AC voltmeter switch 4-position (7-position) for line-to-line (and line to neutral) and off indications.
   2. Ammeter switches 4-position (7-position) for line-to-line (and line to neutral) and off indications.

B. Anti-condensation heater - each switch equipment section shall contain a factory installed sealed 300 watt, nominal, anti-condensation resistance heating element, with automatic on-off adjustable thermostat and humidistat control, factory wired to fused terminals. Voltage 120 volt, 240 volt, 277 volt, or 480 volt, 60Hz, AC as indicated on the Drawings.

2.7 RATING NAMEPLATES

A. The integrated switchgear assembly shall be provided with a nameplate indicating the Manufacturer's drawing number and the following: voltage ratings (kV, nominal; kV, maximum design; kV, BIL); main bus continuous rating (amperes); short-circuit ratings (amperes, rms symmetrical and MVA three-phase symmetrical at rated nominal voltage); and the momentary and fault-closing ratings (amperes, rms asymmetrical).

B. Each individual bay shall bear a nameplate indicating the ratings of the interrupter device (amperes continuous and interrupting); the rating of fuse in amperes; and the catalog number of the fuse units or refill units (if any).

2.8 TAMPER RESISTANT METAL HOUSING OUTDOOR - NON WALKIN

A. Fabricated, NEMA 3R, non-walk-in sectional 11 gauge metal enclosed, modular housings, weatherproof, tamper resistant. Housing shall be constructed with internal structural frames, suitable to house independent free standing medium voltage switchgear, as shown on the Drawings.

B. Provide an open bottom, for bottom entry of underground conduits, with structural frame base for mounting on a concrete slab. Domed roof to shed water. Housing shall be provided with cooling louver air vents, with screen guards behind louvers, quantity and size per Manufacturer recommendation.

C. Full height hinged doors, front, sides and rear of each exposed section requiring equipment access for installation, operation or maintenance. Door, stainless steel hinges, pad-lockable three point door latching, with hold open lock rods and recessed penta-head tamper resistant bolt, accessible behind door latch. Doors shall be removable and full height to provide unobstructed access to equipment inside the housing.

D. The metal enclosure shall be assembled as an integral unit for mounting on a concrete pad. There shall be no exposed screws, bolts, or other fastening devices, which are externally removable. There shall be no unobstructed openings through which foreign objects such as sticks, rods, or wires might contact live parts. There shall be means for padlocking the compartment doors. There shall be means of bolting unit securely to a concrete pad.

E. The metal enclosure shall be sized to allow unobstructed access to operate and maintain the equipment installed inside the enclosure. Enclosure shall be internally braced to comply with California Seismic Zone 4.

F. The hinge and padlocking assemblies shall be made of stainless steel corrosion-resistant material. Stainless steel hinge pins of 3/8-inch minimum diameter shall be provided.

G. Lifting provisions in accordance with ANSI Standards shall be provided. Jacking and rolling provisions shall be provided.

H. Ground pads connections with threaded fittings for grounding.

I. Finish shall be electrostatically applied finish paint over iron oxide rust inhibitor primer. Finish color shall be Manufacturer's standard color olive green Munsel #7GY3.29/1.5. The bottom side and bottom 6 inches of the equipment shall be coated with 4 MIL minimum thickness rust inhibitor undercoating over finish paint, on all interior surfaces. Finish withstand test without face corrosion or blistering:
   1. Salt spray withstands - 2000 hours ASTM B117.
   2. Humidity withstands - 750 hour ASTM D2247.

J. Exposed Hardware and Hinges shall be Stainless Steel type 302 or 304, tamper resistant.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Electrical Installation shall conform to ANSI C2, NFPA 70, and to the requirements specified herein. All equipment and materials shall be new unless indicated or specified otherwise.

B. Anchoring of Switchgear shall be per California Seismic Zone 4.

C. Torque interconnecting bussing bolts and anchor bolts per Manufacturer's directions.

D. Install and connect equipment, furnished under this or other sections as indicated on Project Drawings, the approved Shop Drawing, and as specified herein.

3.2 INSTALLATION PADS FOR PAD-MOUNT EQUIPMENT

A. General
   1. Pad-mount equipment installation shall conform to the Manufacturer's Shop Drawings and mounting instructions and shall include securing the equipment to the concrete slab with a minimum of six anchor bolts, per California Seismic Zone 4. Complete installation and material shall conform to the requirements of ANSI C2 and AASHO-H20 traffic rated structures.
   2. Equipment concrete slabs shall be set level on grade, with 95% minimum machine compacted fill.
   3. Precast concrete slab/pullbox combination shall be as manufactured by Brooks, Jensen, or Christy.

B. Pad-Mounted Equipment
   1. Install on 6-inches thick precast, steel reinforced concrete slab on grade. Provide a precast steel reinforced concrete cable pullbox located directly below and in direct contact to the slab. The slab shall have a precast opening "slot" located under the equipment internal incoming/ outgoing line compartments to allow cable access thru the pullbox(es) into the equipment.
   2. The slab shall have a flush, bolt down, removable 30-inches by 48-inches steel cover safety checker plate, outside of and accessible in front of the equipment cable termination compartments. The removable cover shall allow Field Personnel access into the pullbox under the slab without disturbing the pad-mount equipment.
   3. The slab size shall be 8-feet x 10-feet Increase the slab size to not less than 10-feet by 12-feet where equipment housing or compartments will extend past the edge of an 8 feet by 10 feet slab.
   4. A 48-inches by 72-inches by 48-inches deep (nominal) precast concrete pullboxes shall be provided under the slab for each cable entrance location into the equipment incoming/outgoing line sections. The pullbox shall be installed on a precast concrete base to spread the equipment weight evenly around the perimeter of the box. The pullbox shall "key" into the concrete slab and base.
   5. Provide 10 feet long 5/8-inch diameter copper clad driven ground rod in bottom of each pullbox.
   6. Line side and load side cables shall be racked on opposite walls of each pullbox, with cable racks. Support cable on racks with porcelain cable cradles.
   7. Install slab flat on grade 12-inches thick compacted sand base. Install cable pullboxes on 12-inches thick compacted crushed rock under the box. Install cable boxes directly below the slab in contact with slab "keys" and box base "keys".

3.3 FIELD TESTS AND INSPECTIONS

A. Tests: After the installation has been completed, and the Engineer has been given 10 day notice of the proposed test, the Contractor shall conduct an operating test demonstrating that all equipment and devices operate in accordance with the requirements of the Plans and Specifications.

B. The Relay Setting (where relays are supplied) and Testing shall be performed by a Skilled Technician actively engaged in testing and using test instruments specifically designed and manufactured for that purpose.

C. The Contractor shall provide a Skilled Relay Engineer actively engaged in the business of testing and calibrating power relays and circuit breakers. Certification of such experience shall be provided in writing for the review of the Engineer 10-days before the actual testing is proposed. The Contractor shall furnish Certified Test results and all special equipment required.

D. Testing Shall Verify:
   1. Primary Circuit Polarity Test shall include a DC Test from the current transformer to each terminal block and relay terminal.
   2. Phase Sequence Tests of new circuit connections in relation to existing circuits before interconnections are made.
   3. Relay Switch Operation Test by application of power and current from the portable relay test set.

4. Test insulation of all control and relay circuits to ground with a suitable megohmmeter. Take suitable precautions where electronic devices, instruments and instrument transformers are involved.
5. Operate each switch manually and check operation of auxiliaries, interlocks, contact wipe and gap clearances as identified in the Manufacturer's instructions. Test each pole of each switch for conductivity with a micrometer. Test insulation of each switch phase-to-ground and phase-to-phase with a megohmmeter. High potential test Vacuum or SF6 gas chambers.
6. Check positioning, operation of mechanism and interlocking, both mechanically and electrically.
7. Energize the control circuits, make polarity and voltage checks. Operate through all local control stations. Operate all relay, sensor and interlocking contacts manually to test operation of all circuits related to tripping of equipment.
8. Adjust each protective relay to setting furnished to the Engineer and verify setting using test equipment approved by the Relay Manufacturer, using current sources that do not require correction curves to compensate for wave shape distortion.
9. Test each instrument and meter for proper operation, correct rotation and circuitry. Instruments and meters energized from Instrument Transformer shall be tested at transformer secondary level.
10. Test each current and potential transformer for ratio and polarity. Record values and report deficiencies.

E. Equipment and Apparatus Tests: Unless specific factory-witnessed tests are specified, tests normally made by the Manufacturer will be acceptable for all equipment and apparatus.

F. Certified Phase Rotation Testing shall be performed on connections to existing circuits and between equipment buses prior to energizing equipment.

G. Retesting: rectify and deficiencies found and completely retest work affected by such deficiencies at the Contractor's expense.

H. See General Commissioning Requirements Section 019113 for prefunctional and functional testing requirements.

3.4 GROUNDING (ADDITIONAL REQUIREMENTS)

A. Provide ground conductor connections to ground lugs provided on the equipment.

B. Outdoor Pad Mounted Equipment shall be installed with a minimum of two ¾-inch diameter by 10 feet long copper clad steel ground rods. Install the ground rods spaced a minimum of 10 feet apart. Provide precast concrete pullbox 11-inches by 22-inches by 12-inches deep for each ground rod, mark cover "ground". Connect with underground 1¼-inch conduit and 1#2 minimum ground conductor, between ground rods and equipment.

C. Elbow Bushings Shield shall be individually grounded to insure the shields are at ground potential.

3.5 SIGNS

A. Install "DANGER HIGH VOLTAGE, KEEP OUT, AUTHORIZED PERSONNEL ONLY" on equipment doors, 3-inches high letters.

END OF SECTION 261800
070317/1010006

SECTION 262416
BRANCH CIRCUIT PANELBOARDS AND TERMINAL CABINETS

PART 1 GENERAL

1.1 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.

1.2 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.

1.3 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 Zone-4 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. 100MPH – West Coast States USA and Hawaii.
   b. 150MPH – East Coast States USA, Gulf Coast States USA and Alaska State.
   c. 90MPH – all other USA locations.
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.

B. Refer to General Commissioning Section 019113 for additional requirements.

PART 2 PRODUCTS

2.1 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.
   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, three phase, 4-wire, S/N or 120/240 volt, single phase, 3-wire, S/N.

Branch Circuit Panel as manufactured by:

1. Cutler Hammer "Pow-R-Line 1 or 2" Series
2. General Electric "A" Series
3. Square D "NF/NQ" Series
4. Siemens "P1/P2" Series

D. Distribution Panels as manufactured by:

1. Cutler Hammer "Power-R-Line 3 or 4" Series
2. General Electric "Spectra" Series
3. Square D "I-Line" Series
4. Siemens "P4/P5" 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.

F. Panel Dimensions.

1. Panels with buss sizes 50 ampere thru 400 ampere
   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 ampere
   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-ampere load rating shall not be permitted.
2. Provide Distribution Switchboards instead of Distribution Panels for bus load and circuit load ratings exceeding 800 ampere.

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 panelboard.
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. TVSS - Transient Voltage Surge Suppresser

1. Provide each of the following branch circuit panel and distribution panel types with a TVSS and RF filtering:
   a. 208/120 volt - single phase and/or three phase.
   b. 120/240 volt - single phase.
   c. 480/277 volt - single phase and/or three phase.
   d. All distribution panels.
2. The TVSS shall be installed inside the respective panel housing and shall be factory connected to each main phase, ground and neutral bus inside the panel.
3. The TVSS monitor/annunciator indicators shall be visible only when the panel access door is in the open position.
4. Provide a 20-ampere 3-pole (2-pole for single-phase panels) branch circuit protection device in each panel for TVSS connection.
5. The TVSS device and panel shall be UL labeled and listed for combined use. See related Specification Sections for additional TVSS requirements.

K. 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 Zone-4 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. 100MPH – West Coast States USA and Hawaii.
   b. 150MPH – East Coast States USA, Gulf Coast States USA and Alaska State.
   c. 90MPH – all other USA locations.
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.

2.2 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.

C/B and/or Bus Rating	Circuit Voltage	Short Circuit Amp.
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-ampere buss and smaller; Non-emergency branch circuit panelboards 400-ampere 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-ampere bus and smaller; Emergency branch circuit panelboards 400-ampere 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.

2.3 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 ampere and larger;
      a. Shall be Insulated Case Circuit Breaker type ICCB.
   5. Main circuit breakers for branch circuit panelboards 400 ampere 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-ampere trip shall be Molded Case Circuit Breakers type-MCCB and/or Current Limiting Circuit Breakers type-CLCB.
   7. All circuit breakers 100 ampere 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.
   8. Refer to Specification Section 262413 and/or 261100 for additional circuit breaker requirements.

B. Manufacturer

1. Circuit breakers as manufactured by the following companies only are acceptable:
   a. Cutler Hammer
   b. General Electric Co.
   c. Square D Co.
   d. Siemens

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-ampere circuit size and smaller.
   b. 240 volt – 208/120 volt, 100 ampere 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.
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 ampere at 240 volts shall be twins mounted. Switches rated through 60 ampere and 480 volts shall be twins mounted. Provisions for padlocking in the “on” and/or “off” positions. 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.

2.4 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.

2.5 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 ⅝-inch plywood 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-ampere 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

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

3.2 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. Provide a red and white Bakelite nameplate with ½-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.

3.3 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 262416
070317/1010006

SECTION 262419
MOTOR CONTROL EQUIPMENT

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Provide Schematic "Ladder-Type" logic control wiring diagrams and "point-to-point" control wiring diagrams showing the control system for HVAC equipment and other electrical equipment.

B. Provide Nameplate Engraving Schedule.

C. Submit full-scale time/current transparencies on log/log paper for all fuses, circuit breakers, ground fault system devices, and relays.

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 current settings to provide the 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, electric panels and control panels, motor control centers, combination motor starters, 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 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.

PART 2 PRODUCTS

2.1 GENERAL

A. Division 240000 HVAC/Plumbing

Refer to Division 260000 Mechanical and Plumbing Contract Documents and Shop Drawings for additional electrical work and material requirements.

1. Provide all control devices including timeswitches, relays, auxiliary contacts, voltage transformers, and interlocks.
2. Provide all raceways, conduit wire, circuits, outlets, and interconnections of starters as required for HVAC and Plumbing systems.

B. Special Considerations

1. Mount all auxiliary relays and timeswitches in an isolated compartment inside motor control equipment unless otherwise indicated.
2. Whether or not shown on Mechanical and Plumbing Contract Documents and/or control schedules, where motors are controlled by external devices (i.e., thermostats, relays, float or pressure switches, etc.) or interlocked with other motors, provide each magnetic motor starter with a "Hand-Off-Auto" selector switch in starter cover. Other magnetic motor starters provide a "Start-Stop" push-button station in starter cover.
3. Motor starters, motor controllers and circuit feeder tap devices for motor circuits shall be rated and labeled for control of all electric motor design types A, B, C, D, and E pursuant to the requirements of the NEC

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

1. The complete motor control equipment assembly; including circuit protection devices, motor controllers, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested.
   a. Wind loading for outdoor locations.
   b. Earthquake Seismic Zone-4 withstand and CBC/IBC Seismic withstand all indoor and all outdoor equipment locations.
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 not less than as follows and as required by AHJ:
   a. 100MPH – West Coast States USA and Hawaii.
   b. 150MPH – East Coast States USA, Gulf Coast States USA and Alaska State.
   c. 90MPH – all other USA locations.
5. Acceptance Test Seismic Qualification of proposed motor control equipment 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.

D. Motor Control Equipment as manufactured by:

1. General Electric; or Square D; or Cutler-Hammer; or Allen-Bradley; or Siemens.

2.2 MANUAL MOTOR STARTERS

A. Provide flush or surface mounting manual motor starters with number of poles and size of thermal overload heaters as required for the motor being controlled (equipped with overload heaters, one for each motor lead). Back boxes shall be supplied with all flush mounting starters, whether they are toggle type requiring only a 4-inch square outlet box or the larger type requiring a special box. Provide cover designed to accept the particular unit.

B. Unless otherwise noted on the Drawings, all manual starters for single phase motors, smaller than 1 h.p. shall be the compact toggle type. Manual starters for all single phase motors, 1 to 5 h.p. and all three phase motors up to 5 h.p. shall be the heavy-duty type.

C. Where manual motor starter is shown with pilot light, the pilot light shall be installed in a separate outlet box adjacent to the starter outlet with engraved nameplate to indicate function of pilot light. Pilot lights shall be push-to-test style.

2.3 MOTOR STARTERS - 50/60HZ AC INDUCTION ELECTRIC MOTORS

A. General

1. Motor starters shall be horsepower rated for the motor connected to the starter, air insulated, with NEMA rating.
2. Motor starter coils and controls shall be designed to operate on the control voltage indicated on the Control Diagrams and Specifications. The motor starters shall reliably pick-up and seal-in at 80% through 110% of their coil control voltage.
3. Under voltage release for motor starter coil circuit shall automatically drop motor starter off the line when the line voltage drops below normal operating voltage. Under voltage release shall be field adjustable 80% to 95% of nominal voltage with field adjustable dropout delay 0.1 to 3 seconds minimum for starters larger than NEMA Size 1. The under voltage release shall reset automatically when line voltage level returns too normal. The reset time delay shall be a 0.1 to 60-second field adjustable time range for starters larger than NEMA Size 1.
4. Each motor starter control circuit shall be independently fused.
5. Three phase motor starters controlling three phase motors, five horsepower and larger shall provide integral motor single phasing protection. The starter shall automatically "open", turn off electrical power to the connected motor in the event of the loss of one or more circuit phases, lock out and require manual resetting of the single phase protection to restart the magnetic motor starter. Provide single-phase annunciator. Provide adjustable time delay, minimum range 0.1 to 3 seconds for initiating single phase shut down.
6. Starter units shall be equipped with individual control power transformers (grounded type) with secondary and primary control power fuses. One secondary lead shall be grounded in the unit.
   a. The unit disconnect shall be equipped with a normally open contact to isolate the control circuit from the source when the controller disconnect is open.
   b. The control power transformer VA load rating shall include the motor starter, additional internal and external control devices connected to the motor starter, to insure control power voltage drop does not exceed 5% of nominal rating.
7. Starter units shall be equipped with three motor overload elements, one for each phase, with automatic lockout, external overload indicating flag/pilot light and manual reset external push-button. Trip rating characteristics of the overload elements shall be as recommended by Motor Manufacturer.
   a. Motor overload protection relays shall be bi-metal (non-melting) “heater-element” type or solid-state type, for motor starters NEMA Size 1 and smaller.
   b. Motor overload protection relays for motor starters larger than NEMA Size 1 shall be solid-state type.
8. Pilot light indicators shall be provided with "Push-to-Test" feature. Provide a capacitor in parallel with the starters stop-start control relay circuit, to permit the motor starter control circuit to “drop-out” (turn-off) and prevent “capacitive-holding” (capacitive coupling) on control circuits with “long” (excessive distance) control circuit wiring.
9. Each starter shall be equipped with a minimum of one normally open and one normally closed auxiliary spare contact. Provide additional auxiliary control contacts for interlocking with system control circuits as indicated on the Drawings and Specifications. Auxiliary contacts shall be field convertible for normally open or normally closed operation. Contacts shall be rated not less than 10 amps at 120 volt 60Hz, AC, but in no case shall the auxiliary contacts be rated for less ampere or lower voltage than the connected control circuit.
10. Motor starters larger than NEMA Size 1, provide a running time meter 0 to 99999 hours minimum range, and an operations counter 0 to 9999 meter minimum operations start count range. Meters shall be field resettable with maintained memory during power outages of any length.

11. Minimum starter size shall be NEMA 1, but in no case less than indicated on the Drawings or Specifications.
12. Verify the exact motor connection requirements; motor locked rotor/full load current, NEMA Code letter and voltage characteristics with the supplier of each motor. Motor starters shall comply with the identified requirements.
13. Each starter shall be equipped with "Hand-off-Auto" switch or stop-start push-button as required.
14. An auxiliary relay contact for remote alarm annunciation shall provide common trouble annunciation for any of the starter automatic protection systems. The alarm contact shall automatically reset when the starter is reset.
15. Provide each motor starter main "start" control relay or starter coil as applicable, with a magnetic coil auxiliary control “pilot” relay. The contacts of the auxiliary control relay shall directly control the starting, running and stopping control voltage of the motor starter main control coil circuit. The coil of the auxiliary relay shall condition and match the voltage and in rush of each motor starter to the requirements of the incoming control circuit.
16. Provide a transient surge suppressor for each motor starter coil, to limit voltage transients induced by the motor starter coil operation and to protect the motor starting circuit from voltage transients.
17. Motor starters connected to engine generator emergency power supply source (either direct connection or connection through an automatic transfer switch) shall each be provided with a field adjustable (0.1 - 180 seconds) "start" (on delay) time delay, to provide "staggered" sequenced starting of the connected motor load.

B. Full Voltage Non Reversing (FVNR), Unless Noted Otherwise
   1. Across the line full voltage magnetic electromechanical motor starter.
   2. Provide FVNR motor starter for motor sizes through fifty horsepower (241 to 600 volt) and through thirty horsepower (240 volt and under) where the motor is connected to normal power utility source, unless noted otherwise on Drawings.

C. Two Speed Motor Starters
   1. The 2-speed motor starters shall be compatible with the connected motor and shall provide automatic 2-speed control of separate high speed and low speed motor winding or consequent pole 2-speed motors as applicable. The starters shall be constant horsepower, constant torque or variable torque as applicable for the motor connected to the starter.
   2. Low speed compelling control shall compel the motor starter to always start the motor on low speed before switching to high speed. Compelling control shall be manual switch selectable as either "in" or "out" (bypass) of the motor control circuits.

D. Reduced Voltage Non-Reversing (RVNR)
   1. General
      a. The reduced voltage starter shall reduce both motor starting current and motor starting torque.
      b. Reduced voltage starters shall be closed transition types.
      c. Provide RVNR motor starters for motors larger than thirty horsepower (240 volt and below) and larger than fifty horsepower (over 240 volts), reduced voltage type (Where the motor starter circuit is connected to engine generator emergency power source for motors larger than five horsepower, provide each respective motor with RVNR reduced voltage motor starters).
      d. Starters shall provide field adjustable time periods for acceleration (reduced voltage) and transition (transfer to full voltage) modes, with failure to transfer lockouts and pilot light annunciators. Adjustable time range shall be 0.1 to 15 seconds.
      e. Duty cycle - NEMA rated medium duty, starters shall provide for not less than one 15-second duration starter operation in each 4-minute interval for a 1-hour period, followed by a cool down rest period of 2-hours before the duty cycle is repeated. Provide automatic temperature lockout to prevent exceeding starter duty cycle.
      f. Reduced Voltage Non-Reversing (RVNR) Motor starters shall be types described in the following paragraphs.

2. Autotransformer type reduced voltage starter
   a. Auto transformers on each phase with field adjustable transformer voltage taps for 50%, 65%, and 80% motor terminal starting voltages.
   b. Magnetic electromechanical motor contactor type.

2.4 COMBINATION MOTOR STARTERS

A. General
   1. Combination motor starters shall consist of a feeder tap device, motor starter and enclosure. Voltage and amperage rating as indicated on Drawings.
   2. Combination motor starter shall not be less than NEMA Size 1, but in no case less than indicated on the Drawings.
   3. Unit shall be self-contained floor standing, wall mounted NEMA 1 enclosures or as indicated on the Drawings. Constructed, Tested and Listed in accordance with NEMA, ANSI and UL Standards.
   4. Combination motor starters as manufactured by General Electric, Westinghouse, Square D, Cutler Hammer or equal.
   5. Provide incoming line and outgoing load terminations, size and capacity to match connections shown.

B. Construction
   1. NEMA styles metal enclosed, with full height hinged access door. 12-gauge welded frame members and 14 gauge panel members. All parts shall be removable and accessible from the front for ease of maintenance and rearrangement.
   2. Provide removable lifting points and permanent anchor mounting points on the enclosure.
   3. Hinged doors shall be mounted with removable pin hinges and secured with quarter turn indicating fasteners. A door interlock with manual defeat override shall prevent access to unit interior when the feeder tap device is in the "on" position.
   4. Each metal surface shall be phosphatizing prime rust inhibitor painted and baked Enamel Finish Painted Manufacturer's standard color.

C. Combination Motor Starter Short Circuit Coordination Protection
   1. The combination motor starter shall be constructed and tested to comply with the following requirements.
   2. Type 1 Coordination:
      Under short circuit conditions the contactor/motor starter shall cause no danger to persons or installation. Continued re-use shall be permitted after service, repair or replacement of parts.
   3. Type 2 Coordination:
      a. Under short circuit conditions the contactor/motor starter shall cause no danger to persons or installation. Continued re-use shall be permitted without requiring any service, repair or replacement of parts.
      b. Motor starters shall also comply with International Electromechanical Committee (IEC) Type-2 short circuit protection, as recommended by the Manufacturer’s published protection tables and as Certified by UL.

D. Energy Efficient Motor Protection
   1. Where a combination motor starter is connected to a high efficiency motor, provide one of the following modifications to the starters or circuit disconnects. The modification shall prevent unnecessary tripping from locked rotor high inrush motor starting current:
      a. Circuit breaker or MCP short circuit protection - Provide circuit breaker/MCP with adjustable magnetic current trip for high inrush motor starting current, or adjustable time delay trip for high magnetic current motor inrush damping.
      b. Switch and fuse motor short circuit protection - Provide fuses with sufficient inherent time delay to allow passage of high magnetic current inrush motor starting current.

PART 3 EXECUTION

3.1 INDIVIDUAL COMBINATION MOTOR STARTERS

A. Install motor control equipment in accordance with Manufacturer's written instructions and applicable portions of NEMA "Standards of Installations" for switchboards and motor control centers and individual motor starters.

3.2 IDENTIFICATION

A. Provide a red and white bake lite nameplate with ½-inch high letters fastened to face of dead-front plate, to read: "DANGER 480 (actual volts) VOLTS, KEEP OUT, AUTHORIZED PERSONNEL ONLY".

B. Manufacturer shall stencil the panel number and name of the connected motor circuit on each Device and Equipment Section to correspond to identification on the Drawing.

C. Identification plates and numbers shall be attached with screws or twist lock fasteners. Adhesive attachment of any kind as the only method of attachment shall not be used.

3.3 SETTINGS AND ADJUSTMENTS

A. Program and set control function sequences, time delays, and protective device settings for correct system operation.

B. Test all timing, control sequences and motor rotation direction for proper operation. Correct deficiencies and retest until proper operation is confirmed.

C. Refer to General Commissioning Section 019113 for additional requirements.

END OF SECTION 262419
070317/1010006

SECTION 263210
AUTOMATIC TRANSFER SWITCH

PART 1 GENERAL

1.1 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 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. Emergency Electrical System Operation:

1. Automatic Transfer Switch - ATS unit(s) in combination with the respective engine generator(s) shall automatically detect and respond to normal source and emergency source electrical system power anomalies and disruptions.
2. When normal source anomalies or disruptions are detected by ATS unit(s), the engine generator(s) shall automatically start-and-run, subsequently the ATS unit(s) shall automatically transfer the connected (load-add) to the generator(s).
3. Load-shed and load-add functions shall all be based on assigned emergency load priorities. ATS sequential operations based on load priority assignments.
4. Total start-run-load-add sequence time shall not exceed 10-seconds for priority #1 life safety emergency electrical loads, after detection of normal source anomalies or disruptions. Total start-run-load-add sequence time shall not exceed 60-seconds for non-life safety emergency electrical loads, after detection of normal source anomalies or disruptions.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit product data sheets for all switches, relays, controllers, power supplies, cabinets, etc.

B. Submit Detailed Shop Drawings including Dimensioned Plans, Elevations, Details, Schematic and Point-To-Point Wiring Diagrams and descriptive literature for all component parts and cabinets.

C. Submit Worst Case Voltage Drop Calculations on control circuits.

D. Quality Control Additional Requirements

1. General
   The equipment shall be listed, labeled and approved for the application shown in the Contract Documents, as Building Code mandated, emergency electrical power supply equipment, complying with the most recent version of the install requirements of the following applicable standards. The following standard shall become requirements of and are included in the Contract Documents:
2. Underwriters Laboratory – UL
   a. UL – 1008 Standards for Transfer Switch Equipment.
   b. UL – 508 Industrial Control Equipment
3. National Fire Protection Agency – NFPA
   a. NFPA – 70 National Electrical Code.
   b. NFPA – 99 Essential Electrical Systems.
   c. NFPA – 101 Emergency and Standby Power Systems.
4. National Electrical Equipment Manufacturer's – NEMA
   a. NEMA – ICS-10 AC Automatic Transfer Switches.
5. Institute of Electrical and Electronic Engineers – IEEE
   a. IEEE – 446 Recommended Practices for Emergency and Stand by Power Systems for Commercial and Industrial Applications.

6. International Electro-technical Commission - IEC
    a. IEC-947.6.1 Low Voltage switchgear and Control gear; Multifunction Equipment; Automatic Transfer Switching Equipment.

E. Short Circuit, Coordination and Arc-Flash (Additional Requirements)
1. Perform and submit engineered settings for each Automatic transfer Switch assembly equipment location, showing the correct time and current 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. Automatic Transfer Switch equipment 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.

F. Seismic Earthquake and Wind Loading Withstand, Testing and Certification (Additional Requirements)
1. The complete Automatic Transfer Switch assembly; including circuit protection devices, meter, housings/enclosures, transfer mechanisms, accessories, supports/anchors etc., shall be designed, manufactured and tested.
    a. Wind loading all outdoor equipment locations.
    b. Earthquake Seismic Zone 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 transfer test after completion of seismic event shake-table simulation. Acceptance test seismic qualification of proposed ATS 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. 100MPH-West Coast States USA and Hawaii.
    b. 150MPH-East Coast States USA, Gulf Coast States USA and Alaska State.
    c. 90MPH-all other USA locations.
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

2.1 TRANSFER SWITCH MECHANISM

A. General

1. Provide Automatic Transfer Switch with bypass/isolation switch (ATS) system, with quantity of poles, amperage, voltage and withstand ratings as shown on the Plans. The system shall be the product of one Manufacturer.
2. The ATS shall be rated for all classes of loads including 100% tungsten filament lamp loads, electric induction motor loads and solid state switching power supply loads.
3. As manufactured by ASCO; or Russell; or Zenith controls.

B. Operation

1. Electrical operation shall be accomplished by a momentarily energized single direct operating mechanism, which receives power from the source to which the load is being transferred. Fuse or thermal protection of the main operation shall not be required to ensure compliance and/or correct operation. The total operating transfer time shall not exceed one-sixth of a second (10Hz). Mechanical locking in each position shall be accomplished without the aid of springs, latching solenoids, gear mechanisms or motor operators.
2. Operation shall be inherently double-throw where all contacts move simultaneously and with no programmed delay in a mid-position. Electrical spacing shall not be less than those listed in Table 15.1 of UL Std. #1008. Main contact structures not originally manufactured for transfer switch service are not acceptable. An overload or short circuit shall not cause the switch to go to a neutral position.
3. Inspection and replacement of all main and arcing contacts (moveable and stationary) shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors.
4. A UL listed manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to stop the contacts at any point throughout the entire travel including points of contact make and break.
5. ATS shall be 4-pole Phase-A, Phase-B, Phase-C plus switched neutrals, with fully rated neutral transfer contacts which momentarily (100 milliseconds, maximum) interconnect the neutrals of the sources during the transfer/retransfer operation. The neutrals shall remain interconnected through the main contacts until the phase contacts close on the alternate source. Phase and neutral contacts shall be driven by one single main operator.

2.2 CONTROL PANEL

A. General

A separately mounted logic panel with solid state sensing and timing functions shall provide the following operational characteristics:

1. Time delay on momentary dips in normal source (adjustable 0.5-6.0 seconds), set at 1.0 seconds.
2. Time delay on transfer to emergency for controlled loading of generator (0-5 minutes adjustable 0 to 300 seconds. Set at 0 seconds for each ATS supplying Building Code mandated emergency electrical loads. Set at 15-second sequential additional incremental intervals for each additional ATS supplying electrical loads that are not mandated for emergency standby power source by Building Code regulations.
3. Time delay on retransfer to normal after restoration of normal source (adjustable 0-30 minutes), set at 15 minutes.
4. Selector switch to manually bypass time delay on retransfers.
5. Time delay on engine shutdown (engine cool down) after retransfer to normal (adjustable 0-15 minutes), set at 5 minutes.
6. Close differential voltage sensing of all normal source phases (adjustable pick-up 85-100 percent of nominal and drop out 75% - 98% of pick-up), set at 85% drop out and 95 percent pickup.
7. Independent voltage (adjustable 85% - 100% pick-up) and frequency (adjustable 90% - 100% pick- up) sensing of the emergency source to prevent premature transfer, set at 90 percent voltage and 95% frequency.

8. Test switch for both test with load and test without load (momentary type).
9. Gold plated 10-ampere engine-starting contacts (1-N.C. and 1-N.O.) rated 120 volt AC or D.C.
10. Visual annunciators to indicate ATS connection position (white on normal, yellow on emergency, red for common trouble.
11. Auxiliary contacts each D.P.D.T. (one relay to operate on normal "N" and one relay to operate on emergency “E”) rated 10 ampere 480 VAC.
12. An in-phase monitor shall be provided to control transfer/retransfer operation between live sources so that closure on the alternate source will occur only when the two sources are approaching synchronism and at the instant when the two sources are within plus/minus 60 electrical degrees, max. The monitor shall function over a frequency difference range of plus/ minus 2Hz minimum, with a maximum total transfer operating time of 1/6 of a second (10Hz in the event of abnormal frequency difference (in excess of plus/minus 2Hz) and/or failure of the load-carrying source, the monitor shall be automatically bypassed. The monitor shall not require inter-wiring with generator controls nor active control of generator.
13. All time delay and sensing functions shall be readily field adjustable over the ranges indicated and operate without drift over minus 4 degrees Fahrenheit to 158 degrees Fahrenheit. The logic panel shall be provided with a protective cover and isolation plug in wiring harness between control panel and main transfer panel.
14. Automatic engine generator exerciser to provide adjustable 30-minutes to 60-minutes duration generator start-run and stop sequence, one time per week or one time every 2-weeks. Exercising sequence shall be field selectable with or without load connection and with or without load bank connection. The exerciser shall provide automatic (activate-deactivate) separate control of the engine generator load bank when a load bank is provided with the engine generator system. Note: Where more than one ATS is provided as part of Contract Work, only the master ATS shall be furnished with automatic engine generator exerciser feature.
15. Visual annunciators shall indicate availability of normal and emergency power sources and automatic transfer switch position. A prominent and detailed instruction plate shall be furnished.
16. Emergency engine generator “Stop” pushbutton with lockout, manual reset and audio/visual alarm annunciation.
17. Provide ground fault sensing and indication for each ATS. Shall automatically detect a ground fault condition occurring on electrical circuits connecting to the ATS. Provide audiovisual alarm notification that there is an emergency system ground fault condition. The alarm notification shall occur both local at each ATS and remotely, at the engine generator annunciator panel. The ground fault system shall not cause an interrupt of the operation of the emergency system.

B. Automatic Monitoring, Management and Load Controls
   1. Where more than one Automatic Transfer Switch (ATS) is included in the Contract Scope of Work, and/or where one or more “closed” transition operation ATS is required, provide each ATS with microprocessor based, software controlled, microprocessor controller Programmable Logic Controller (PLC). The respective engine generator(s) shall each also be provided with software Programmable Logic Controllers (PLC). The PLC units and operating software shall be compatible/interoperable with all of the other PLC and software units connected at engine generators, annunciators and ATS equipment.
   2. The PLC shall provide monitoring and visual display of engine generator and ATS analog and digital operating parameters including output voltage, output frequency and output demand load.
   3. Load automatic control, add-and-shed
      a. In the event of an engine generator overload, the PLC shall automatically disconnect (Load-Shed) respective ATS load from emergency generator source, causing the overload condition.
      b. The PLC shall also automatically control sequence-staged loading (Load-Add) using ATS connection to the engine generator source during emergency generator system initial start-run sequence.
      c. The ATS load control process shall prioritize load “shedding” and load “adding” by ATS load type priorities connected to the respective ATS. Shall provide software adjustable time delay for each load “shed” and load “add” priority level.

d. Priority #1 emergency loads shall be setup as the highest priority for load continuity supply for load-add. Priority #1 loads shall be setup as the last load-shed priority. Similar setup logic for load priorities #2, #3, and #4 in sequential descending order of priorities for emergency load add-and-shed functions.

4. The ATS supplying building units Life-Safety and Building Code mandated emergency loads (i.e., life safety exit egress lighting, fire alarm, etc.) shall have the highest priority #1 and #2 respectively, to remain connected and for "first" connected (load-add) and "last" disconnected (load-shed) to the engine generator. Loads connected to other ATS units that are not mandated by Building Codes (i.e., non-life safety loads, refrigerators, UPS, computers, air conditioning, equipment, etc.) shall have the lower priorities #3 and #4 to remain connected and/or disconnected to the engine generator. The PLC load "shed" and load "add" priorities and time delays shall be software programmable.
5. The PLC shall provide visual/audio alarm annunciation of the overload condition(s), engine generator system status/alarms each ATS load connection status and load priority start, at each engine generator location, respective engine generator remote annunciator panel and at the respective ATS.
6. The PLC shall communicate the ATS load shed and load add command controls to the respective PLC equipment in each ATS unit, and assign each ATS with a separate individual load shed and load add priority.
7. The PLC shall provide selective load "lockout" with manual reset upon shed or time delay automatic load restore of each ATS after a load shed event has occurred, software programmable at the PLC.
8. Provide the PLC equipment in each engine generator, in each engine generator remote annunciators, in each Automatic Transfer Switches (ATS) and at the building main fire alarm control panel. Provide PLC common digital/ multiplex communications protocols and operating software, to ensure correct, error-free interoperability among all the PLC units and related equipment.
9. The PLC color display screen with LCD based "touch screen" function, shall display operating status and alarms of each engine generator, and each ATS unit. 10-inches (nominal) diagonal or larger LCD screen size. PLC non-volatile memory storage shall store in memory a minimum of 30-days display information, plus the operating software program controls. Interface port for plug-in connection of portable laptop computer interface to provide uploading to the PLC software programs and downloading system-operating information from the laptop computer.
10. Each PLC shall be rated for operation in the same ambient environments and vibration conditions as the engine generator and respective ATS units.
11. ATS with "closed transition operating mode.
    a. The PLC shall provide monitoring, operational control and status information display of the ATS/Engine Generator "closed" transition and "open" transition systems.
    b. Provide an additional PLC at main electrical service entrance disconnect to monitor and communicate the P.T. and C.T. electric power and current directional flow information, plus utility source voltage and frequency information back to the ATS/generator control system.

2.3 ATS INTERLOCK AND COMMUNICATION

A. General
   1. The ATS equipment and system shall provide communications with each building's system, in addition to the engine generator. The emergency power electrical system shall communicate when the ATS is supplying emergency source electrical power or normal source electrical power.
   2. Provide communication "gateway" protocol for ATS communications compatibility with each building system.

B. Building Fire Alarm System
   1. Building Fire Alarm System, the ATS system shall communicate to the fire alarm system the emergency electrical system status; ready to operate status; running power fail status; trouble and fail-to-run or inoperative status; exercise testing-mode status; over load shed status.

C. Building Automation System – BAS

1. Building Fire Alarm System, the ATS system shall communicate to the BAS the emergency electrical system status; normal ready to operate; running normal power fail; trouble and fail-to-run or inoperative; exercise testing-mode; overload-shed.

D. Building Elevator Interlock

1. Provide transfer switch auxiliary contacts D.P.D.T. rated 480-volt AC 10 amps, for Elevator Interlock. The Elevator Interlock shall signal each elevator controller when a normal source power failure has occurred and the transfer switch has transferred to the emergency source (the elevator interlock shall not operate during automatic generator exercising).
2. The interlock shall signal the elevator control system to operate only one elevator at a time with sequential automatic return to safe-ground level and lock-out. Typical when elevator is operating on the emergency power system.
3. Fire Fighter's override; the elevator control system shall provide automatic manual transfer between each elevator in the building elevator system, to allow each elevator to operate sequentially on emergency power, one elevator at a time.

2.4 ELECTRICAL AND MECHANICAL PERFORMANCE

A. General

The system shall comply with UL Std. #1008 and NEMA Standard. ICS 2-447. In addition, the switch shall meet or exceed the following requirements and be verified by Certified Independent Laboratory Test data:

1. Temperature Rise: Measurements shall be made after the overload and endurance test.
2. Dielectric: Tested after the withstand test at 1960 VAC r.m.s. minimum.
3. Voltage Surge: Control panel voltage surge withstand test per IEEE Std. 472-1974 and voltage impulse withstand test per ICS-1-109.

B. Short circuit fault

1. UL listed to the magnitude of short circuit fault current available ampere RMS symmetrical at the switch terminals plus safety-factor, shall be coordinated with respective line side protective devices.
2. Automatic Transfer Switch and related assemblies shall be fully rated for the withstand, interrupt, and close/latch available short circuit fault current, plus an additional 25% safety-factor, but not less than indicated on the Drawings plus safety-factor.
3. Alternative short-circuit fault "series-rating" withstand and interrupt methods with upstream and down-stream circuit protection systems are not acceptable.
4. The Automatic Transfer Switch equipment system short circuit fault current rating duration shall selectively coordinate with the up-stream and down-stream circuit protection devices time/ current trip characteristics, as determined by the short-circuit fault report submitted by the Contractor.
   a. UL "Umbrella-Rating" for 3Hz duration short circuit fault withstand, closing and opening.
   b. UL "Umbrella-Rating" for 30Hz short circuit fault duration withstand, closing and opening.

2.5 HOUSING ENCLOSURE

A. General

1. The automatic transfer switch and bypass/isolation switch system shall be supplied in a common NEMA 1 enclosure with a barrier between the compartments. Rust inhibitor prime undercoat with Manufacturer's standard color finish final coat of paint.
2. The complete system shall be factory assembled, wired and tested prior to shipment.

B. Connections

1. All line voltage power interconnections shall be silver-plated copper bus bar.
2. Incoming line and load terminations shall be provided for top, bottom and side entry. Rear access to the transfer switch assembly shall not be required. Entire automatic switch assembly shall be constructed for front accessible only.

C. Weatherproof Outdoor Equipment
   1. Equipment indicated as Weather Proof (W.P.) or outdoors shall be enclosed in a NEMA 3R, non-walk-in, and tamper resistant construction. Provide full height hinged doors with provisions for padlocking the doors in the closed position. Install all ATS operator controls and annunciators on the front cover of ATS located securely behind the NEMA-3R ATS front access door. Do not install ATS operator controls and annunciators in the NEMA-3R-access door.
   2. Provide a nominal 300-watt sealed, resistance type, anti-condensation heater in each equipment section. Heaters shall be controlled automatically by Thermostats and Humidistats. A circuit breaker shall be provided to supply ATS "utility" source buss voltage to the heaters, all prewired by the Manufacturer to fused terminals.
   3. Finish shall be electrostatically applied finish paint over iron oxide rust inhibitor primer. Finish color shall be Manufacturer's standard color, olive green Munsel #7GY3.29/1.5. The bottom side and bottom 6 inches of floor standing equipment shall be coated with 4-mil minimum thickness rust inhibitor undercoating over finish paint, on all interior surfaces. Finish withstand test without face corrosion or blistering:
      a. Salt spray withstands - 2000 hours ASTM B117.
      b. Humidity withstands – 750-hours ASTM D2247.
   4. Exposed hardware and hinges shall be Stainless Steel type 302 or 304, tamper resistant.

PART 3 EXECUTION

3.1 GENERAL

A. The Manufacturer shall certify that the complete unit meets or exceeds the seismic requirements of the California Administrative Code Titles 21 and 24.

B. Certification: The Manufacturer shall provide a notarized letter certifying compliance with all the requirements of this Specification. The Certification shall identify, by serial number(s), the equipment involved.

3.2 TEST AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. Settings
   1. Set and calibrate field-adjustable intervals, timing settings, load-shed, load-add and delays, and engine exerciser.
   2. Check remote communications connects, protocols, interfaces and controls with remote related building systems.
   3. A Factory-Authorized Service Technician shall inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

B. Testing
   1. Following completion of automatic transfer switch and generator installation and after making proper adjustments and settings, site tests shall be performed in accordance with Manufacturer's written instructions to demonstrate that each automatic transfer switch functions satisfactory and as specified.
   2. Advise Owner's Representative of the site testing 10-days prior to the scheduled date. Provide Certified Field Test Reports three copies within 14-days following successful completion of the site tests to the Owner's Representative. Test reports shall describe adjustments and settings made and site tests performed.
   3. Operational tests shall include the following:
      a. Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.
      b. Inspect for physical damage, proper installation connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer operation.
      d. Perform manual transfer operation.

4. After energizing circuits, demonstrate the interlocking sequence and operational function for each automatic transfer switch.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss phase-to-ground voltage for each phase of normal.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout and inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, re-transfer time delay on restoration of normal power, and engine cool-down and shut-down.
5. Coordinate with testing of ground and fault protective devices for power delivery from both sources.
    a. Verify grounding connections and locations and ratings of sensors.
    b. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    c. Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
    d. Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
    e. Low phase-to-ground voltage shall be simulated for each phase of normal source.
    f. Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
    g. Manual and automatic transfer and bypass isolation functions shall be verified.
6. If any defects or deficiencies are detected, correct the defects and repeat the test until all test-pass is achieved.

3.3 ELECTRIC POWER AND CONTROL CIRCUITS (ADDITIONAL REQUIREMENTS)

A. General
1. Provide NEC Class-1, Divison-1 explosion-proof conduit fittings and seals on each conduit entering or exiting the engine generator location from the ATS.
2. Terminal blocks with barriered terminals shall be provided for all control wiring terminator points. Control wiring shall be run in horizontal and vertical, isolated, internal metal wireways and shall be carried across hinges in laced bundles. Wire terminators shall be crimp-on type spade terminal
3. Secondary control wiring shall be a minimum of 14 AWG stranded copper type SIS 600-volt insulation.
4. Control circuits shall have circuit number tags at each termination or break in the wire to match circuit numbers on terminal strips and control wiring diagrams.
5. Provide quantity and AWG conductor size/type capacity, circuit conductor “lug” connection landings, compatible with connections shown on the Drawings.

B. Additional Conduit Homeruns
1. Provide the following minimum quantity and size conduit and wire, to connect each ATS controls, generators, monitoring, and annunciators, shall also comply with ATS and Engine Generator Manufacturer’s recommendations. Install the conduit and wire from each ATS to the respective engine generator, monitoring and control equipment and locations. Refer to Drawings for additional requirements. Install conduit underground and/or concealed in building structure at all locations.
    a. 1.25-inch conduit 5#10 plus 1#10 ground and 12#14 from each ATS to engine generator, for engine automatic stop-start controls, overload shed and add, engine exercising, engine generator “emergency-stop”, control and monitoring.
    b. ATS line voltage feeder circuits for generator source, normal source and load feeders.
    c. 1.0-inch conduit 4#10 to each elevator equipment /machine room controller unit – elevator interlock.
    d. 0.75-inch conduit 8#14 to fire alarm control panel for fire alarm system monitoring and control of ATS.

e. 1.0-inch conduit 8#12 to HVAC – BAS building automation system master control transponder.
f. Two 1.5-inch conduits to the generator, with engine generator control circuits for momentary parallel-synchronized operation of the engine generator with the Electric Utility Company incoming electric service. Circuit conductor quantity and type as recommended by Manufacturer.

END OF SECTION 263210
022416/1010006

SECTION 263215
STANDBY POWER

PART 1 GENERAL

1.1 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. Engine Generator
   1. Furnish and install emergency continuous standby diesel (USA-grade #2 ULSD-CARB) fuel engine driven generator with all accessories and other appurtenant work and materials required for a complete operational installation.
      a. The fuel provided shall comply with; be listed by; and shall be approved by, the California Air Resources Board (CARB Fuel Specifications and Test Methods).
   2. The standby power system shall include an electric generating set rated to deliver 250kW, 313kVa at 0.8 power factor. Engine not less than 1500Bhp minimum, V-16 cylinders at 1800RPM.
   3. Unit rating shall not be based on the peak output curve of the prime mover. Unit rating shall be based on the continuous standby rating at the altitude above sea level of the engine generator installation site. Performance engine curves shall be submitted.
   4. The engine generator output voltage shall be 480/277 volts, 3 phase, 4 wire, 60Hz AC.
   5. The engine generator set shall be built, tested and shipped by the Manufacturer of the unit so there is one source of supply and responsibility. As manufactured by Cummins; or Kohler; or Caterpillar.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General
   1. The Factory Authorized Distributor supplying the equipment shall have full service and parts available on a 24-hour basis located within 200 miles of the Project Site. Instruct the involved Contractors on the proper method of installing the engine generator unit and related equipment.
   2. Make Shop Drawings to scale, showing overall dimensions and other dimensions required for proper installation of equipment and external connections. Identify clearly each item on Drawings to show piece of equipment it represents. Indicate corrosion resisting treatment and finish.
   3. Shop Drawings shall include complete Floor Plan layout of room and/or area show install location of all equipment and indicate equipment layout, conduits, junction boxes, etc., complete with dimensions and clearances for review of the Owner's Representative.
   4. Diagrams shall be both schematic and elementary point-to-point using standard symbols and with components arranged in logical sequence, so that system operation can be checked easily. Where special symbols are used or where function of components is not obvious, include suitable legend or functional guide. Number all terminals for external wiring connections on diagrams. A composite control wiring diagram shall be provided showing the integrated control and load connections of the following:
      a. Engine generator and control panel.
      b. Engine generator remote annunciator panel.
      c. Automatic transfer switch.
      d. Battery charger.
      e. Special interlocks noted on Drawings.
      f. Fuel system.
      g. Load testing system.

h. Connect to control and monitoring systems.

5. Submit prototype, independent test lab, certified test reports for engine generator unit of identical size, type and construction showing conformance with performance requirements outlined in the Contract Documents. Plus the following additional tests:
   a. Maximum power level.
   b. Maximum motor starting capacity.
   c. Fuel consumption.
   d. Engine/alternator cooling air flow (heat rejection).
   e. Transient response and steady state governing.
   f. Alternator temperature rise.
   g. Single step load pickup.
   h. Harmonic analysis and voltage wave form.
   i. Three phase short circuit test for mechanical electrical strength.

B. Pollution Emissions

1. The engine generator shall comply with the air pollution controls and pollution emission limits regulations of the Authorities Having Jurisdiction (AHJ), including but not limited to the following: A Manufacturer's "Certified Equipment Permit" shall be provided showing the proposed equipment AHJ approval permits.
2. United States Federal Government.
   a. Environmental Protection Agency (USEPA) – Local Region Having Jurisdiction.
3. State of California:
   a. California Environmental Quality Act – CEQA.
   b. California Environmental Protection Agency (CALEPA) and California Air Resource Board (CARB).
   c. California Air Quality Management District (AQMD) District Office Having Local Jurisdiction at the Project Site location.
   d. Additional Local and City/County Pollution Control District Authorities Having Jurisdiction.
4. The emission pollutants tests and reports shall include but not be limited to the following:
   a. Reactive organic gases – (ROG)
   b. Nitrogen oxides – (NO_X)
   c. Carbon monoxide – (CO)
   d. Particulate matter – (PM)
   e. Sulfur oxides – (SO_X)
   f. Non Methane Hydrocarbons – NMHC
   g. Non Methane Organic Gas – NMOG
   h. Total Organic Compounds – TOC
   i. Carbon Dioxide – CO_2
   j. Fuel storage containment, fuel leak detection and leak monitoring system.
5. Pollution emissions and Particulate Matter (PM):
   a. The engine generator pollution emissions and particulate emissions shall not exceed AHJ requirements.
   b. In no case shall particulate emissions exceed the following: The engine combustion air exhaust (discharge) emissions shall not exceed Particulate Matter (PM) emissions of 0.01 grams/Bhp-HR (engine brake horsepower each hour) at all engine generator load factors.
6. The engine generator Manufacturer shall prepare pollution emissions reports for the proposed engine generator. The reports shall be in the format and include the documentation required by the AHJ for emissions regulations. The engine generator operational pollution emissions and controls shall comply with the requirements and regulations of the AHJ for the intended engine generator use. If the engine generator requires the addition of emission controls and/or abatement controls to comply with AHJ requirements, provide said controls as part of the Contract Document requirements.

7. Apply for and obtain in the name of the Contractor and the Owner respectively the Permits to construct and Permits to operate the engine generator system as a Building Code mandated Emergency Stand-by Power System. Provide four copies of each permit application for review by the Owner's Representative prior to submittal to AHJ. Obtain the AHJ approval of the permits, along with a written description of any additional actions the Owner must accomplish. Submit all documents to the Owner's Representative.
    a. The design intention hours of engine operation (engine running) are less than 199 hours in a 12-consecutive month period of time, to supply Building Code mandated emergency electrical power. The actual operating (running) time of the engine generator will be determined by uncontrollable and unpredictable conditions, such as; acts of God; equipment failures; Utility Company outages; rolling blackouts, etc. The design intent estimated engine operating time includes an estimated 30-hours of programmable time for testing (exercising) maintenance of the engine generator system.
    b. The following is a partial list of "non-code" mandated electric loads that will be connected to the standby engine generator system:
        - UPS equipment
        - Refrigerator/freezer motor load equipment
        - Radio frequency transmitter
        - Intrusion detection/security alarm
        - Time-of-day master clock system
        - PBX telephone, intercom, paging equipment
        - HVAC air conditioning
        - Other loads as shown in the Contract Documents

C. Quality Control
1. General
   The equipment shall be listed, labeled and approved for the application shown in the Contract Documents, as Building Code mandated, emergency electrical power supply equipment, complying with the most recent versions of the requirements of the following applicable Standards. The following Standards shall become requirements of and are included in the Contract Documents:
2. Underwriters Laboratory – UL
    a. UL – 142, Steel aboveground Tanks for Flammable and Combustible Liquids.
    b. UL - 2085, Fire Rated (vaulted) aboveground tanks for Flammable and Combustible Liquids. Fuel Tanks.
    c. UL – 508, Industrial Control Equipment.
    d. UL – 2200, Standard for Safety for Stationary Engine Generators.
3. National Fire Protection Association – NFPA
    a. NFPA – 30, Flammable and Combustible Liquids Code.
    b. NFPA – 37, Stationary Combustion Engines and Gas Turbines.
    c. NFPA – 70, National Electrical Code.
    d. NFPA – 99, Essential Electrical Systems for Healthcare Facilities.
    e. NFPA – 110, Emergency and Standby Power Systems.
4. National Electrical Manufacturer's Association – NEMA
    a. NEMA – MG1.1, Electric Motors and Generators
5. American National Standards Institute – ANSI
    a. ANSI – 43, Recommended practice for Testing Insulation Resistance of Rotating Machinery
6. Institute of Electrical and Electronic Engineers – IEEE
    a. IEEE – 446 Recommended Practice for Emergency and Standby Power Systems
7. National Electrical Contractors Association – NECA; National Electrical Installation Standards – NEIS.
    a. NECA – EGSA404, NEIS – Recommended Practice for Installing Generator Sets.
8. State of California Air Resources Board (CARB).

D. Operating Manuals
1. Provide in acceptable form, three bound copies of Operating Manuals for electrical equipment.
2. Provide catalog cuts, functional description of operation, wiring diagrams, operating and maintenance instructions, parts lists and other data useful and necessary for complete Maintenance and Operation of equipment.

3. Deliver operating manuals to the OWNER'S Representative.

E. Special Considerations
   1. Manufacturer shall have printed literature and brochures on the complete unit describing the standard series specified.
   2. Critical Speeds: Each complete engine-generator unit shall be free of critical speeds of either a major or minor order that will endanger the satisfactory operation of the unit or cause undue vibration in any part of the plant equipment or structure. Satisfactory operation will be considered endangered if torsional vibration stresses exceed 5,000 psi within 10% above or below rated engine speed. Copies of a summary of computations of critical speeds shall be submitted.
   3. All openings for fuel lines, air intake/discharge, engine exhaust, conduits etc. shall be temporarily capped or plugged prior to shipment.

F. Short Circuit, Coordination and Arc-Flash (Additional Requirements)
   1. Perform and submit Engineered Settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and current settings to provide the 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

G. Seismic Earthquake and Wind Loading Withstand, Testing and Certification (Additional Requirements)
   1. The complete engine generator assembly; including attached fuel storage and supply systems, cooling systems, exhaust system, housings/enclosures, accessories, supports/anchors etc., shall be designed, manufactured and tested for wind loading and earthquake seismic withstand at the installation location.
   2. Shall withstand, survive and maintain continuous non-interrupted operation (running) during the seismic event occurrences. Continued normal operation after the wind event and seismic event occurrences have abated.
   3. Shall include demonstrations of successful start-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. 100MPH-West Coast States USA and Hawaii.
      b. 150MPH-East Coast States USA, Gulf Coast States USA and Alaska States.
      c. 90MPH-all other USA locations.
   5. Acceptance test seismic qualification of proposed engine generator shall employ triple axis shake-table simulation of the Required Response Spectrum (RRS) seismic event motion, certified and approved by the AHJ.
   6. All unit fluids shall be at full-capacity during the seismic test.
   7. 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

2.1 ENGINE

A. General

1. The engine shall be diesel drive, two or four cycle, water cooled type with unit mounted radiator cooling, turbo-charged, operating speed of 1800 RPM. Engine speed shall be governed by an electronic governor with electrical activator, as manufactured by Barber Colman; Woodward Governor Company.
2. A unit mounted, 24 volt, D.C. 30-ampere battery charging alternator and solid state regulator shall be provided.
3. Engine shall be rated for continuous standby duty.
4. The engine lubrication system shall be pressure type with engine driven lubrication oil pump and replaceable oil filter element, full flow oil filter. Breather pipe suitable for adding engine-lubricating oil while the engine is running shall be provided. Provide lubricating oil per Manufacturers recommendations.
5. The engine throttle control system shall provide a minimum discrete engine speed adjustment sensitivity of 0.15Hz, measured at the generator output under all loading conditions.
6. Engine Governor:
   a. The Engine Generator shall be furnished with digital electronic Isochronous Engine Governor and Generator Voltage Regulator.
   b. The Engine Governor shall provide measurement of the engine operating temperature, automatically adjust the engine governing gains as a fraction of the engine temperature to prevent unstable governor operation due to temperature.
   c. The engine generator output frequency control shall incorporate output frequency adjustable transient slew-rate, to prevent engine generator instability resulting from “pulsing” emergency loads.
7. The engine generator set package shall comply with the manufacturing requirements and test requirements of UL-2200.
8. Provide modifications for remote control operation from the ATS. Generator speed, frequency, power factor and load sharing shall be controlled from the ATS. The engine generator shall be modified for parallel and synchronized operation with the Electric Utility Company incoming electric service. Provide additional engine generator controls required by the ATS Manufacturer, to ensure correct and safe operation of the engine generator parallel and synchronized operation with the Utility Company. The engine generator interconnection additional protection shall comply with:
   a. IEEE-1547, 1547.1, 1547.2 and 1547.3 including pending draft standards.
   b. Serving electric utility company requirements.
   c. State of California Rule #21 recommendations and requirements.

B. Engine Horsepower

1. The engine horsepower output shall be sized to provide sufficient capacity to operate all specified engine generator accessories and still maintain the electrical output and performance characteristics specified for the engine generator unit. The engine horsepower rating shall be increased to compensate for the following factors at the installation location. Submit calculations showing allowances for each condition:
   a. Installation altitude above sea level and specified ambient air temperatures.
   b. Engine driven radiator cooling fan.
   c. Cooling air positive and negative back pressure increases caused by radiators, radiator mounted load banks, generator housing, sound attenuation baffles, air louvers and cooling air intake/discharge air ducts.
   d. Engine driven fuel pumps.
   e. Engine driven coolant pumps.
   f. Engine driven battery charger.
   g. Generator coupling/transmission gearing losses.
   h. Engine driven lubrication pumps.
   i. Engine combustion exhaust mufflers and engine exhaust system piping.
   j. Engine combustion air intake filters and intake air silencers.
   k. Engine driven super chargers and turbo chargers.

l. Engine fuel source/type derating factors.
m. Engine combustion exhaust emission controls, with back-pressure monitoring and reporting system.

C. Engine Controls
1. Oil pressure, and temperature gauges.
2. Water temperature and pressure gauges.
3. Battery charge alternator rate ammeter.
4. Solid state, plug-in module monitor system including visible low water temperature alarm, individual fault lights, alarm terminals and engine shutdown with manual reset for over crank, over speed, high water temperature, low fuel, high oil temperature and low oil pressure. Low oil pressure, high water temperature and low fuel shall provide pre-alarm prior to engine shutdown. Over speed shall provide both positive air and fuel supply shut-off at approximately 110% of operating RPM.
5. Solid state plug-in type cycle “cranking” start control. After three failed cranking attempts of approximately 75 seconds each, the crank/rest cycles will be terminated, with alarm and manual reset.

2.2 ALTERNATOR (GENERATOR)

A. General
1. The line voltage alternator shall be a revolving field, broad range, 4-pole, brushless, designed for minimum reactance, low voltage waveform distortion and maximum efficiency. The rotor amortisseur windings shall improve the AC waveform, reduce field heating with single phase or unbalanced loads and act as a stabilizer for paralleling. The rotor shall be dynamically balanced, connected and aligned to the engine by a semi-flexible disc coupling.
2. The three phase alternator shall be twelve lead reconnectable. The insulation shall be NEMA MG1-1.65. Temperature rise 80 degrees centigrade per NEMA MG1-22.40. Insulation shall be vacuum impregnated for improved protection and cooling.
3. The exciter shall be brushless, three phase, full wave rectified, with silicon diodes mounted on common rotor shaft and sized for electric induction maximum motor starting capacity.
4. The voltage regulator shall be digital type solid state, including silicon controlled rectifiers with three phase-controlled sensing circuits. The system shall feature automatic voltage reduction if the load demand exceeds the engine capacity, to eliminate engine stalling due to an occasional engine misfire or temporary overload such as motor starting and shall prevent overheating or blowing of fuses of the load circuit, due to saturation of magnetic components, when the voltage remains constant at reduced frequency. The voltage reference shall be a temperature compensated Zener Diode. The voltage regulator shall eliminate voltage regulator incorrect operation caused by voltage distortion resulting from non-linear emergency loads.
5. The winding “pitch” of each generator shall be matched and shall be the same for each generator. The engine “governor”, generator “voltage regulator” and generator “exciter” shall all be the same Manufacturer and type for each engine generator.
6. Anti-condensation heater in the generator line voltage alternator with automatic “on-off” control shall prevent condensation from occurring inside the alternator. 120/208 volt 60Hz operation, single or 3-phase as indicated on the Drawings. Provide automatic cut-off when engine is running and automatic thermostat control.

B. Harmonic Load compensation
1. The engine generator alternator system, generator windings, voltage regulator and exciter shall be compensated for "SCR" type loads on the output side, with 50 percent 3rd, 5th, 7th and 9th harmonic voltage and current content in the connected loads.
2. SCR emergency type loads include Variable Speed Motor Drives (VFD); uninterruptible power supplies (UPS), computer/data processing equipment, lighting electronic dimming equipment, audio/video equipment, etc.

C. Generator Controls
1. Manual reset exciter automatic circuit breaker.
2. Output load voltmeter, true RMS.
3. Output load ammeter, true RMS.

4. Output load power factor meters, for both negative and positive power factors.
5. Combination voltmeter-ammeter selector switch for phase-to-phase and phase-to-neutral meter input.
6. Analog meters shall be not less than 4-inches in size. Digital meter digits shall be not less than 0.25-inch high. Meter accuracy ± 1%.
7. Elapsed running time meter, 0-99999 hour's minimum, non-resettable.
8. Output load frequency meter (true relative to engine speed).
9. Output load voltage manual adjusting rheostat, plus or minus 5% rated output voltage and voltage regulator.
10. Startup cranking controls.
11. Solid state digital electronic protection devices with adjustable settings for; loss of excitation; output overvoltage protection; under/over frequency; generator winding differential overcurrent protection; reverse VAR (loss of field) protection to prevent pole-slippage and mechanical impact damage because of out-of-phase paralleling action with the utility source or other engine generators.
12. Generator control panel illumination, with on-off manual switch illumination control.
13. Output load circuit breaker mounted in Nema I enclosure on the side of the generator control panel. A signal light shall be provided to indicate breaker is in the "off" or tripped position. Circuit breaker shall be mounted on vibration isolators. Circuit breaker shall be rated for "service entrance" use. Circuit breaker shall be 100 percent continuous load rated. The circuit breaker shall be sized at not less than 115% of the generator rated electric load output and voltage. The output load circuit breakers shall be provided with adjustable trip settings as follows:
    a. Instantaneous pickup.
    b. Long time pickup and longtime delay.
    c. Provide ground fault detection sensor on the generator main disconnect. The sensor shall provide audio/visual alarm indication in the event of a ground fault detection occurring in the electrical line voltage output connecting into the generator main disconnect. The ground fault condition shall also provide audio/visual alarm indication at the engine generator remote annunciator panel. The ground fault system shall not cause an interruption of the emergency system.
14. Three position control selector switch "Automatic-Off-Run" when the switch is in the "off" position a red pilot light shall activate with a nameplate "Generator is not operable" when light is on.
15. Remote stop-start connection terminals.
16. Reset pushbutton to reset automatic shutdown lockout circuits.
17. All controls shall be identified as to function with engraved nameplates or engraved control panel. Nameplates shall be fastened with bolts, nuts and lock washers.
18. Combination engine and generator control panel shall be shock mounted over the rear end of the alternator, and include switched panel lights, controls shall be solid state type.
19. Provide a factory prewired terminal panel in the engine generator control panel. The terminal panel shall provide individual "landing" and termination points for each control/annunciator circuit entering and exiting the engine generator location. Each termination point shall be vibration resistant, insulated, barriered, and identified with individual circuit numbers/names.
20. Exposed control and monitoring wiring shall be installed in liquid tight fuel, oil and fire resistant flexible raceways within the engine generator housing.
21. Engine generator emergency shutdown:
    a. Provide "Emergency-Stop" manual control station switch to automatically stop-shutdown engine generators when the switch is activated.
    b. Weather resistant; tamper resistant manual operation, double action (breakable glass) with auto-lockout on activation. Flush mounted or surface mounted +42-inches on wall to accommodate wall condition.
    c. Provide alarm indication on generator control panel when switch is activated. Provide a switch at each entry door location into the engine generator enclosure/ room; each main fire alarm control panel; and at each engine generator automatic transfer switch. Provide 5#10 – 1-inch conduit homerun to engine generator from each switch.
    d. As manufactured by ASCO #124 series, Square-D or equal.

D. Automatic Load Controls, Engine Generator Controls and Monitoring-Programmable Logic Controller

1. Each engine generator shall be provided with microprocessor based, software controlled, engine generator management Programmable Logic Controller (PLC), rated specifically for engine generator monitoring and control. The respective remote annunciators and ATS units shall each also be provided with compatible matching software for Programmable Logic Controllers (PLC) engine generator systems.
2. The PLC shall provide monitoring, control and visual display of engine generator analog and digital operating parameters including output voltage, output frequency and output demand load.
3. In the event of an engine generator overload, the PLC shall automatically disconnect (shed) respective ATS load causing the overload condition.
4. The ATS load control process shall prioritize load "shedding" and load "adding" by ATS load types connected to the respective ATS, and shall provide software adjustable time delay for each load "shed/add" priority level. The PLC shall provide individual independent load "shed" and load "add" priority for each ATS connected to the engine generator.
5. The ATS units supplying Building Code mandated emergency loads (i.e., life safety exit egress lighting, fire alarm, etc.) shall have the highest priority to remain connected to the engine generator. Loads connected to other ATS units that are not mandated by Building Codes (i.e., non-life safety loads – refrigerators, UPS, computers, air conditioning, telephone equipment, etc.) shall have the lower priorities to remain connected to the engine generator. The PLC load "shed/add" priorities shall be software programmable.
6. The PLC shall provide visual/audio alarm annunciation of the overload condition(s), engine generator system status/alarms and each ATS load connection status, at each engine generator location, respective engine generator remote annunciator panel and at the respective ATS.
7. The PLC shall communicate the ATS load "shed/add" command controls to the respective PLC equipment in each ATS unit, and assign each ATS with a separate individual load "shed/add" priority. Provide the PLC equipment in each engine generator, remote enunciators and Automatic Transfer Switches (ATS). Provide PLC common digital/multiplex communications protocols and operating software, to ensure correct, error-free interoperability among all the PLC units and related equipment.
8. The PLC shall provide selective load "lockout" with manual reset upon shed or time delay automatic load restore of each ATS after a load shed event has occurred, software programmable at the PLC.
9. The PLC color display screen with LCD based "touch screen" function shall display operating status and alarms of the engine generator, fuel system and each ATS unit. 10-inch diagonal or larger LCD screen size. PLC non-volatile memory storage shall store in memory a minimum of 30-days display information, plus the operating software program controls. Interface port for plug-in connection of portable laptop computer interface to provide uploading to the PLC software programs and downloading system operating information from the laptop computer.
10. Each PLC shall be rated for operation in the same ambient environments and vibration conditions as the engine generator.

2.3 UNIT ENGINE AND GENERATOR COMBINED PERFORMANCE

A. General

1. Frequency Regulation: Isochronous no-load to rated load.
2. Voltage Regulation: Steady state voltage regulation shall be within plus or minus 2% of rated voltage from no-load to full rated load.
3. Recovery to stable operation after application of full rated load shall occur within 5-seconds.
4. Steady State Operation: The frequency variation shall not exceed plus or minus 0.15Hz. Voltage variation shall not exceed plus or minus 1% of their mean value. The steady state operation shall be based on constant loads ranging from no load to full rated load.
5. Electromagnetic Interference Level Attenuation shall exceed requirements for generator connected loads including but not limited to: data processing equipment, Uninterruptible Power Supplies (UPS), standard AM and FM radio, CATV and commercial television, marine radio-

telephone equipment. Tele-phone influence factor shall be less than fifty pursuant to NEMA MG1-22.43.

6. Waveform Deviation Factor shall be less than 0.06 line-to-line and line- to-neutral per NEMA MG1-22.42.
7. RMS Voltage Dip: The sustained RMS voltage dip shall be less than 18% of rated voltage when full 3 phase load and rated power factor is applied to the alternator.
8. Peak kVA: The available peak kVA shall be suitable for simultaneous electric motor starting as shown on the Contract Documents. Quantity and size of motors as indicated on the Drawings, shown connected to engine generator system. The generator shall sustain at least 90% of no load voltage for 10 seconds with 250% of rated load at zero power factor connected to its terminals. Submit test data.

2.4 ENGINE GENERATOR REMOTE ALARM ANNUNCIATOR PANEL

A. General

1. A remote mounted alarm annunciator panel in a NEMA 3R flush mounted enclosure with clear tamper resistant locking cover door, at each location shown on the Drawings, but in no case less than one annunciator for each engine generator.

B. Annunciator Display

1. The annunciator shall include the following with appropriate sensors “sending” units installed in each engine generator, fuel system and ATS units.
   a. Generating: Generating power ready for load.
   b. Over crank: Electric plant failed to start.
   c. Low Oil Press: Low engine lube oil pressure.
   d. Hi Engine Temp: Pre-alarm and final excessive cooling water temperature.
   e. Low Engine Temp: Low engine cooling water jacket temperature.
   f. Over speed: Excessive RPM of electric plant.
   g. Low Fuel: Pre-alarm and final low fuel supply.
   h. Low Battery Voltage: Low starting battery voltage.
   i. Hi Battery Voltage: High starting battery voltage.
   j. Weak starting battery alarm.
   k. Overvoltage: Generator output over voltage.
   l. Fuel Spill: Each fuel storage unit rupture basin fuel spill detection.
   m. Low coolant: Engine low coolant level.
   n. Low oil level: Low engine lube oil level.
   o. PER engine emissions common alarm and status.
   p. Generator ground fault alarm.
   q. ATS alarms for each ATS.
      1) ATS: connected to normal utility source.
      2) ATS: connected to generator source.
         Engine generators supplying more than one Automatic Transfer Switch (ATS) shall include the following additional alarm annunciation for each individual ATS:
      3) ATS: generator overload shed.
2. Audible alert:
   a. An audible signal will sound with the visual signals, except for conditions paragraph 1.a; 1.q.1 and 1.q.2 above. A switch will be incorporated to silence the audible alarm until the alarm condition is corrected. The audible alarm shall then sound until the switch is repositioned to the "normal" position.

2.5 FUEL

A. Fuel Connections

1. Engine mounted and piped dual parallel, in line “Baldwin” or “Dahl” fuel filters. Each fuel filter twin chamber, 3-stage combination fuel filter/water Separator. Provide valving for replacing individual filters while engine is running and valves for draining accumulated water from each filter.

2. Flexible, bronze, fuel line connectors' minimum 24-inches in length for supply and return fuel line connections. Leak proof connectors type and size to match and be compatible with respective fuel lines and engine connectors.
3. Main remote fuel storage tank system, fuel transfer pumping, and fuel line piping under related Contract Document Sections and Drawings.

B. Maximum Permitted Engine Fuel Flow
1. The full rated fuel consumption for the engine generator shall not exceed the following:
   a. Maximum engine full load fuel consumption shall not exceed "(insert gallons)" gallons per hour.
   b. Maximum engine fuel flow rate shall not exceed: (engine full load fuel consumption) plus (excess fuel flow for engine components cooling) "(insert gallons)" gallons per hour.

2.6 COOLING

A. Liquid Cooling
1. The engine shall have an engine driven centrifugal type water circulating pump with bypass, for circulating thermostat controlled water through the engine cooling system.
2. 50% water and 50% permanent solution anti-freeze protection.

B. Radiator
1. Radiator Cooling: A unit-mounted radiator and piping, with pusher type fan shall be provided for full load continuous standby operation in an ambient 24 hour temperature of 110 degrees Fahrenheit and including the "load-bank" cooling airflow requirement. Provide a fan shroud and protective guard. Radiator coolant drain petcock and pressure relief filler cap.
2. Radiator shall be provided with metal duct flanges for connection of flexible discharge air duct.
3. Provide, flexible metal, rust resistant, watertight, discharge air duct. The air duct shall connect airtight from the radiator/radiator mount loadbank duct flanges to the respective wall louver air discharge opening located to the front direction of the radiator. Flair the air duct to direct all radiator/loadbank cooling discharge air through louvers and to match the size of the radiator/ loadbank configuration to the larger size of the wall louver configuration.
4. The pusher radiator fan shall be sized to provide proper cooling air flow to overcome the static back pressure of the supply and exhaust cooling air ducts, radiator, plus the radiator mounted resistance "load-banks", plus the discharge air ducts and louvers associated with the engine generator installation. Submit back pressure air flow calculations for review.

C. Water Jacket Heater
1. Water jacket engine electric resistance preheater shall provide positive water circulation, thermostatically controlled to operate within range of 100 degrees to 120 degrees Fahrenheit. In an ambient temperature of zero degrees centigrade, 120/208 volt 60Hz AC, single or three phase, as indicated on Drawings. Provide automatic power cut-off contactor/relay when engine is running and to cycle the operation of the heaters. Provide shut-off bypass valves on heaters at both the inlet and outlet sides, readily accessible. As manufactured by "Kim-Hotstart".
   a. 11 feet from a property line.
   b. 4 feet from an exterior wall or roof.
   c. 11 feet from windows, building openings, air outlets and air intakes for the building.

2.7 ACCESSORIES

A. Batteries:
1. Starting batteries shall be lead acid type. Batteries shall provide sufficient capacity to provide the equivalent of three 75-second duration engine cranking operations with a 60 second rest period between cranking operations at 77 degrees F. with a cold engine and final battery voltage of 1.75 volts per cell at 77 degrees Fahrenheit. Specific gravity of fully charged battery shall not exceed 1.220 at 77 degrees Fahrenheit. Batteries shall be equipped with removable cell caps utilizing catalytic conversion of hydrogen battery gases. Provide insulated stranded copper conductors to connect batteries to generator electric starting motors(s), sized to insure a full load voltage drop of not more than 5% when starting the engine.

2. Battery Box: Battery box shall be rated outdoor weatherproof. Acid resistant fiberglass battery box with hinged, padlocking cover. Electrically insulated seismic earthquake restraints and anchors. Install batteries in battery box. Install battery box on floor directly adjacent to engine generator for indoor locations. Install battery box inside engine generator housing for outdoor locations.
3. Battery Charger: Completely solid state. DC output shall be voltage regulated and current limited so as not to require a cranking disconnect relay. The charger shall include: full wave output, silicon semiconductors, automatic boost (equalize) mode, surge suppression, individual potentiometer adjustments for boost and float voltage, DC output voltmeter and ammeter, AC and DC fuse, input and output terminals, DC output completely isolated from AC input, and shall completely recharge full discharged batteries within a 12 hour period. Input voltage shall be 208-volt, as indicated on the Drawings. NEMA 3R for outdoor locations and NEMA 1 enclosure for indoor locations.
4. Weak Battery Alarm: Monitor the engine starting battery voltage under start-up load, while the engine is cranking in the start-mode. If the starting battery voltage drops for too long a time period, (as recommended by Battery Manufacturer) a "weak-battery" audible warning shall sound, along with annunciator visual alarm indication.

B. Engine Exhaust Silencer
1. Super-critical grade exhaust silencer with companion flanges, rain-cap, and seamless stainless steel flexible exhaust tubing, 18-inch minimum length.
2. Provide approximately 8-inch length of rigid schedule 40 black iron pipe between the exhaust manifold and the flexible tubing. Sweep elbows a minimum radius of three times the exhaust pipe diameter shall be used for exhaust pipe bends.
3. Provide safety, continuous heat guards on all engine exhaust piping, manifolds and silencers located below 10 feet above finish grade.
4. Provide automatic gravity operated "rain-cap" on discharge, to prevent entry of rain and vermin. Horizontal or vertical exhaust discharge, for compatibility with install location.
5. Provide drain "petcock" at the low point of each exhaust stack to allow condensate gravity drain of engine exhaust system.

C. Engine Exhaust Emissions and Particulate Emissions (PER) Reduction
1. The PER shall be a self-contained, passive, self-regenerating, continuously self-cleaning (regenerating) particulate filter, with internal precious metal catalysts in conjunction with the particulate filters. Connect the PER "in-line" with engine combustion air exhaust discharge system. PER high temperature 304 stainless steel housing, supports and fittings. The PER system, supports, and housing shall withstand and operate correctly with the engine exhaust flow output, pressures, physical characteristics and thermal conditions of the engine exhaust system. The PER shall be specially designed and manufactured for stationary, internal combustion engine operation and for 2-stroke or 4-stroke engines as applicable.
2. The PER shall actively reduce environmentally harmful products of ENGINE combustion present in the engine combustion air exhaust. The PER shall not cause an increase in any other engine exhaust toxic contaminants:
   a. Diesel particulates reduction (without increasing $N0^2$ content) not less than……85% reduction
   b. Carbon Monoxide (CO) not less than ……70% reduction
   c. Total Hydro Carbons (THC) not less than……70% reduction
3. The PER shall be Tested, Approved and Certified to comply with Federal - EPA, State and Local Air Quantity Management Districts and applicable AHJ, by the Engine Generator Manufacturer, for safe correct operation of the proposed engine/PER combination and by the PER Manufacturer for AHJ compliance and engine compatibility. The PER shall be listed and approved by and with each AHJ.
4. A microprocessor - based, data logger and alarm, with data logger and sensors installed to Record PER temperature and engine exhaust back pressure, shall detect if engine combustion exhaust back pressure and/or PER operating temperatures comply with and/or exceeds engine and PER Manufacturer's recommendations. The alarm status shall also be reported on the engine Generator Remote Annunciator Panel (EGAP) and the engine generator internal control panel.

5. Provide a permanent sign on the engine generator fuel input port and each related fuel storage tank, minimum ¼-inch high block letters:
   "Warning this engine is equipped with an engine exhaust particulate combination filter/ catalyzer. Diesel fuel for this unit shall be Ultra Low Sulfur Diesel fuel (ULSD), maximum of 15-PPM sulfur content or less, as measured by weight. The fuel shall be CARB Tested and Certified. Damage to the equipment and failure to operate may occur if the correct ULSD/ CARB fuel is not used!"
6. PER systems requiring the addition of additives to the engine postproduction fuel supply are not acceptable.
7. Standby Emergency Unit Operation with Emissions Particulate PER Filter
   a. Standby Engine Generator Load Factor with PER Particulate PER filter. The particulate emissions shall not exceed AHJ requirements, but in no case shall particulate emissions exceed the following:
      1) The engine combustion air exhaust (discharge) shall not exceed particulate emissions of 0.01 grams/Bhp-HR (engine brake horse power each hour) at all engine generator load factors.

D. Enclosure and Mounting
   1. Spring type, vibration/seismic isolators, with a one-gravity lateral (horizontal) acceleration withstand rating seismic earthquake restraints. The install location of the engine generator shall be included in selecting the correct isolators, for example the seismic forces on the roof of a building are substantially greater then seismic forces at ground level.
   2. Radiator, engine and alternator shall be mounted on a twin steel "I" beam base. Base shall be suitable for lifting, hoisting, or skidding of the entire unit into installation position.
   3. The engine generator shall be completely housed in a NEMA 3R outdoor rated weather-protective metal enclosure NEMA 1, indoor rated protective metal enclosure. The generator housing shall be attached to and mounted on the same skid steel frame "I" beam base as the engine generator. Provide at least four hinged, removable side access doors and rear hinged control panel access doors. Provide locking hasps on all access doors. Engine exhaust silencer shall be side inlet type, mounted on top of housing and terminate with rain cap. Engine exhaust transitioning through housing shall be provided with a suitable rain shield to prevent water from entering the housing.
   4. Engine generator unit and housing shall have a Manufacturer's standard weather protective finish paint color, applied over a rust inhibitor prime coat on all exposed and concealed surfaces.

E. Engine Combustion Air
   1. Engine combustion air intake silencers to limit the air intake noise to less than the engine exhaust silencer noise level.
   2. Replaceable, dry element, heavy duty, intake combustion air filters.

2.8 LIQUID FUEL TANK (SKID BASE MOUNTED BELOW THE ENGINE/GENERATOR)

A. General
   1. The fuel day tank for each generator shall be of the self-contained skid base mount type. Tanks shall be completely housed within the generator enclosure. Tank shall be welded metal construction. The fuel tank shall structurally support the weight and provide the anchorage for the complete engine generator assembly, plus a 150% safety factor.
   2. Tank finish and color to match generator finish and color. Interior of fuel tank shall be epoxy coated. The exterior bottom of the tank shall be provided with additional layer of anti-rust coating.
   3. The fuel tank holding capacity shall provide a minimum of twenty-four (plus 10% additional reserve) hours of continuous full load engine generator operation. Approximately 10% of fuel shall remain in tank to prevent fuel fouling and loss of fuel suction priming. Provide fuel filler neck with locking removable cap. The filler shall extend outside the engine generator enclosure.
   4. The maximum height addition to the engine generator unit caused by the skid base mount tank shall not exceed 15-inches. The fuel tank footprint shall not extend beyond the engine generator/radiator footprint.

5. Tank shall be provided with 2-fuel level detection switches and floats, low level engine shut down (set at approximately 10% fuel remaining to prevent fuel fouling of engine) and low level pre-alarm (set at 90-minutes remaining fuel) prior to shut down. Provide fuel level float activated "sight" gage. Provide threaded connection points on the tank for auxiliary fuel pump/ filter “polish” system.
6. Fuel tank assembly anchoring and attachment shall be designed for Earthquake Seismic Zone 4 with the tank full of fuel, and with the engine generator installed on the tank. The engine generator spring/vibration seismic isolators shall be provided between the engine generator “I Beams” and top of fuel tank.
7. Provided threaded removable insert plugs in all fuel tank line connections.
8. Fuel tank shall have a sump area at the bottom of the tank to collect water and sediment, with “drain-valve” to allow gravity draining of sump-fuel sediment.

B. Rupture Fuel Containment

1. Tank unit shall have rupture basin (double wall construction) with accidental spillage detection alarm contacts. Rupture basin capacity shall be sized at a minimum of 115% of fuel tank capacity. Rupture basin shall have 0.5-inch pet lock valve at the bottom of the basin to drain contents into portable container. Basin shall be enclosed to prevent collection of dust, debris and water.

2.9 LOAD BANKS

A. General

1. Each engine generator set shall have a resistive load bank, which shall operate connected to the generator electric output only under exercising function of the engine generator. The total kW rating of the load resistors shall be not less than 50 percent of the full load output kW rating of the generator to which it is connected, but in no case less than required by Engine Generator Manufacturer to maintain the Unit Manufacturer’s warranty.
2. Load bank shall be housed in a NEMA 3R weather protective enclosure, mounted integrally to the engine on the front of the radiator, and cooled by the airflow across the radiator. Provide air duct metal flanges on the inlet and exhaust sides of the load bank. The load bank housing shall be rust inhibited galvanized steel after fabrication, with Manufacturer's standard finish color finish paint. The load bank's load chamber shall have the physical dimensions coordinated with the radiator's duct flange. The radiator fan's cooling capacity (airflow) and engine standby rating horsepower shall be increased as necessary to prevent excessive static back pressure build up caused by the load bank.
3. The load bank resistors shall be mounted in field removable trays for servicing capability.
4. Resistors shall be constructed of high temperature alloy capable of continuous operation at 1920° Fahrenheit with a melting point of 2750° Fahrenheit and designed to operate at an average of 750° Fahrenheit. The resistors shall be assembled in a three phase array with the phase-to-phase resistor current balanced within 2% and an overall kW tolerance within 5% of its nominal rating.
5. A circuit breaker and load bank connection circuits shall be provided in the engine generator supplying the load bank. The circuit breaker shall be sized at 125% of the full load current of the load bank. Provide fuse protection for each individual load bank section.
6. Provide automatic electric contactors as required to activate load bank in the exercising mode. Provide all control interlocks with the automatic transfer switch as required to provide the following functions: load bank on-line.
    a. ATS exercising timer starts generator and brings load bank on-line.
    b. Exercising function operates for pre-selected period of time with load bank connected at 100% of load bank capacity.
    c. At end of exercise period, and prior to the engine "cool down" run out, the load bank shall be automatically taken off-line.
    d. If utility power outage occurs during the exercise period, the load bank shall immediately be de-energized (under any operating mode) before the emergency load automatic transfer switches change position; generator shall continue to run during the disconnect of the load bank.
    e. Provide a load bank “on-off-automatic” selector switch. The switch shall control the operational function of the load bank. The “on” position shall by-pass automatic operation

and connect the load bank to the engine generator only when the generator is “running” at stabilized voltage output and rated RPM. The “on” switch position shall not override the automatic disconnect of the load bank in the event of an “emergency power” generator operation mode. The “off” position shall by-pass automatic operation, disconnect the load bank and prevent automatic operation of the load bank.

f. Provide red (load bank connected) and green (load bank disconnected) indicating lights with “push-to test” for each load bank step load.

g. Load bank system shall be as manufactured by Load Technology, Inc., La Mirada, California; AVTRON; Simplex or equal.

2.10 DIESEL FUEL AUTOMATIC MAINTENANCE (DFAM)

A. General

1. Automatic, self-contained fuel maintenance system to remove particulates, microbial growths and water contamination in each engine distillate fuel storage system. The multistage filter system shall operate in a parallel pipe connection arrangement with the engine main fuel supply system.
2. Provide fuel chemical treatment, anti-microbial dispersant and preservative fuel additives to the fuel storage system.
3. As manufactured by Fuel Technologies Inc. (http://www.fueltechinc.com); ALGAEX-STS Series (http://www.algae-x.com).

B. Components

1. Fuel filter pump:
   a. 120 volt 60Hz AC self-priming, electric motor driven fuel pump(s), directing the fuel through multi-stage particulate removal filtering and water removal separators, transporting fuel to and from the fuel storage tank.
   b. Pump fuel lift capacity not less than 1.4 gallons per minute at 15-foot head suction lift.
   c. Spurgear, iron casing, Viton sealed, pressure relieve valve, pump construction.
2. Piping connections:
   a. Piping connections for “dirty” fuel suction supply from the engine generator fuel tank sump. Filtered fuel return to the engine generator fuel storage tank fuel return directly to main storage tank bypassing day-tank within 6-inches of the bottom of the tank at the opposite end from the fuel sump.
   b. Provide ball valves on the filter fuel supply and return fuel pipelines, for system isolation and maintenance.
   c. Provide “foot-valve” in the fuel storage tank filter supply line pipe to keep the filter system primed.
   d. Provide one-way flow “check-valve” on the filter return line pipe to prevent fuel back-flow and siphoning.
   e. Thread connection black iron supply and suction pipes, sizes as recommended by Filter Manufacturer, but not less than 1-inch diameter. Flexible line, final connectors to the fuel tank, to isolate vibrations between equipment.
3. Particulate filters
   a. Particulate filters, removable for filter cleaning and replacement. The filters shall remove and trap particulates in the fuel, 2 microns in size and larger, and flow forced through the filters by the filter pumps.
   b. Suction sensors to detect when filters are 75% or more obstructed with trapped particulates and requires servicing/cleaning.
4. Fuel water separator
   a. Trap and remove not less than 90% of the water contaminating the fuel, flow forced through the water trap by the filter pumps.
   b. “See-through” water trap bowel, with water level sensor probe, to indicate when the trap bowel is 75% or more full with removed water and requires servicing/cleaning.
   c. Trap bowel “spin” on and off removable for servicing and cleaning.

C. Controls
   1. Digital electronic controls for the automatic on-off control, monitoring and trouble alarms reporting of the DFAM system.
   2. Alarms shall monitor and annunciate and be reported on the engine generator remote annunciator panel as follows:
      a. High suction (fuel filter clogged).
      b. High water level in fuel water separator trap bowel.
      c. Fuel leak in the DFAM cabinet.
   3. Operator manual controls.
      a. Operations timer selection and programming.
      b. Alarm indicators and alarm reset.
      c. Suction gauge.
      d. Manual override stop-start control.

D. Cabinet
   1. Self-contained Metal Cabinet Manufacturer's standard finish and color, to contain all of the DFAM components.
   2. Tamper-resistant NEMA-4X.
      a. Install DFAM cabinet inside the engine generator housing for outdoor locations.
      b. Install the DFAM cabinet for generators with "base mounted" fuel storage tank at engine generator on floor support brackets/pipe for indoor generator room locations. Engine generators with freestanding day-tank fuel storage; install the DFAM cabinet at the respective fuel day-tank location on floor support brackets/pipe. Mounting height to prevent fuel siphoning.
      c. Provide fuel pipes, power and control conduit/wire connections.
      d. Complete the installation of chemical fuel treatment additive to the fuel storage tank after all engine generator testing and acceptance is completed.

PART 3 EXECUTION

3.1 ENGINE-GENERATOR TESTS

A. General
   1. Before delivery to the site, the engine generator assembled unit shall be given a preliminary operation and load test. The test shall be performed by an approved independent Testing Laboratory. The tests shall include full load test with a load bank of adequate capacity and shall assure performance of all specified function to the satisfaction of the OWNER'S Representative. Upon completion of the preliminary tests, the unit, complete with equipment, shall be delivered and installed at site. Provide four copies of complete test records. A copy shall be framed and mounted in the unit by the Contractor. All shop load tests shall be run at 80% lagging power factor.
   2. Upon completion of the installation work, including the electrical connections, and grounding of equipment and neutral, the Contractor shall provide all necessary facilities, fuel, instruments and equipment, including full capacity load bank required for the load tests, and arrange for final test runs. Field tests to be run at unity power factor with Contractor provided unity power factor load bank and fuel.
      a. Generator shall start and pick up full load at normal voltage and frequency within eight seconds, from a cold start (no pre-running within the previous 12 hours prior to the test).
      b. Load test at 0, ¼, ½, ¾ full load and 105% overload until readings are constant for 10 minutes duration for each.
      c. Four 2-hour duration 100% continuous full load test conducted consecutively with the above test.
   3. Readings required during all tests shall be taken on recently calibrated laboratory instruments as well as those on the equipment and shall include not more than 15-minute intervals during the test period including initial start and at final conclusion prior to shutting down for the following:
      a. Output frequency.
      b. Output voltage.

c. Load current.
d. Load watts and volt-ampere
e. Ambient temperature.
f. Engine, coolant temperature.
g. Radiator and engine exhaust air temperatures.
h. Generator frame temperature at hottest spot.
i. Engine lubricating oil pressure and temperature.
j. Frequency and voltage tests shall include a record of response time recovery from load changes.
k. All adjustments, replacement of unsatisfactory equipment, and retesting shall be made by the Contractor's at the Contractor's own expense.

4. Before acceptance of the equipment, the Contractor shall instruct the Owner's Maintenance Personnel in the Operation and Maintenance of this equipment. Four complete written instructions manuals, operating schedules, parts, lists, blueprints, wiring diagrams, maintenance and repair manuals, Engine and Generator Specifications including actual performance curves shall be submitted to the Owner's Representative before final approval.
5. Perform tests as specified and as requested by the Owner's Representative to prove installation is in accordance with Contract requirements. Perform tests in presence of the Owner's Representative, and furnish all test equipment, facilities, and Technical Personnel required to perform tests.
6. Provide full fuel tank fuel supply, prior to transferring acceptance of the engine generator after completion of tests.

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. 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 engine generator system on both normal power source and emergency power sources. Simulated test time duration for operating connected on the emergency systems shall be not less than 120 continuous minutes without failure or anomalies in the system operation.
3. Record and document electrical demand load and sequence of operations on the engine generator 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
   e. Fire sprinkler pumps.
   f. Elevators.
4. Provide system programming and setup of all control sequences and related equipment including but not limited to:
   a. Automatic Transfer Switches (ATS)
   b. Lighting control system
   c. Fire alarm
   d. (HVAC)
   e. Fuel transfer/storage
   f. Elevators.
   g. Other non-code mandated electrical loads.
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 Owner's Representative certifying commissioning has been performed; all respective systems are operating correctly and document all software setup and each device settings.
8. See General Commissioning Requirements Section 019113 for prefunctional and functional testing requirements.

3.2 GENERATOR INSTALLATION

A. General
   1. The engine-generator shall be mounted on Seismic Zone-4 rated spring isolators and anchor bolts having telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces. Constructed of shatterproof ductile iron per ASTM-A-536 grade G5-45-12, type RJ from California Dynamic Corporation or equal.
   2. Engine generator furnished with a "Skid-Base" fuel tank. The seismic spring anchors shall attached between the fuel tank and engine generator skid-base "I" Beams. The seismic spring anchors shall isolate engine generator vibration from the "skid-base" fuel tank. The skid-base fuel tank shall be anchored to concrete slab for one gravity lateral acceleration seismic earthquake restraint.
   3. Generator engine shall have a crankcase drain pipe that is at least 8-inches from the floor, equipped with a readily accessible positive locking shut-off valve. All units shall have a removable full-length metal drip pan under the engine.
   4. Provide expansion type or cast in place type anchor bolts to anchor generator to equipment slab. Installation shall comply with Seismic requirements of California Code of Regulations Title 21 and Title 24.
   5. Diesel engine fuel shall be Ultra Low Sulfur content (ULSD); CARB tested and certified diesel fuel. Sulfur content shall not exceed 15 Parts Per Million (PPM) content.
   6. Complete all electrical connections, control connectors plumbing and mechanical connections.

3.3 CONTINUOUS MAINTENANCE SERVICE AND PREVENTATIVE MAINTENANCE

A. The Generator Factory Trained Service Personnel shall perform two Field Inspections and Service Maintenance Visits, 4-hours duration each visit excluding travel time, at 6 and 12-calendar months after the engine generator installation connections and testing is complete. The Manufacturer's standard recommended maintenance procedures shall be performed as part of the Contract requirements. A certified and registered letter outlining and describing the maintenance visit work has been completed shall be sent to the Owner's Representative after each visit.

B. The Supplier shall provide documentation of maintaining local 24-hour parts and Factory-Trained Service Personnel within a 200-mile radius of the Project Site with the Shop Drawing submittal.

3.4 ELECTRIC POWER AND CONTROL CIRCUITS

A. General
   1. Provide NEC Class-1, Division-1 explosion-proof conduit fittings and seals on each conduit entering or exiting the engine generator location.
   2. Provide quantity and AWG conductor size/type capacity, circuit conductor "lug" connection landings, compatible with connections shown on the Drawings".
   3. The final conduit/raceway connections to any part of the engine generator from any "fixed" location entrance to the engine generator shall be made with liquid-tight flexible raceway. The raceway shall be UL label and approved for use in the atmosphere environment at the engine generator, shall be oil and fuel resistant.

B. Additional Conduit Homeruns
   1. Provide the following minimum quantity and size conduit and wire, to connect each emergency generator, controls and annunciators. Install the conduit and wire from each engine generator to the respective monitoring and control equipment. Refer to Drawings for additional requirements. Install conduit underground and/or concealed in building structure at all locations.
      a. 1.25-inch conduit - 3#10 and 8#14 to each automatic transfer switch. Engine stop-start controls, overload shedding, engine exercising control, and monitoring.
      b. 1.5-inch conduit - 18#14 and 3#10 to remote engine generator annunciator panel.
      c. 2.5-inch conduit - 4#1 and 1#6 ground, feeder from each engine generator CPP panelboard to the remotely located emergency control power panel/ switchboard source, 208/120 volt (life safety branch). Provide a subfeed 70 ampere 3-pole circuit breaker (100

ampere 3-pole for generator units exceeding 200kW) in the remote panel/ switchboard and connect to the CPP feeder. Refer to Drawings for additional requirements.

d. 1.5-inch and 1-inch conduits - 4#4 and 7#14 respectively to engine generator engine fuel transfer pump control system, fuel storage system, fuel leak detection system and the engine generator CPP panelboard.
e. Two 1-inch conduits 4#10 and 7#14 respectively to engine generator engine fuel "day tank" control system and leak detection system.
f. Branch circuit conduit/wire for CPP panelboard connections to generator lighting, receptacles, engine block heaters, alternator anti-condensation heater, fuel day tank pumps, battery charger, etc.
g. Generator load output feeder circuits.
h. 1.25-inch conduit with 8#10 to main fire alarm control panel, generator "run-fail-ready" monitoring and emergency "run-stop" bypass controls from the fire alarm control panel location.
i. 1-inch conduit with 5#10 to each respective engine generator emergency shutdown control station.
j. 1-inch conduit with 6#10 to each elevator controller, for initiation of emergency power, elevator-recall function.
k. Two 1.5-inch conduit to each automatic transfer switch, with engine generator control circuits for momentary parallel synchronized operation of the engine generator with the Electric Utility Company incoming electric service. Circuit conductor quantity and type as recommended by Manufacturer.

B. Control Power Panel

1. Provide a tamper resistant Control Power branch Circuit Panelboard (CPP) installed at each engine generator. Panel shall be in a NEMA-4x enclosure. Panel rating shall be 100 ampere bus 208/120 volt, 60Hz AC, three phase, 4 wire. The panel shall contain a 70 ampere, 3-pole 100 ampere, 3-pole for generator units exceeding 200kW main circuit breaker; six 20 ampere single pole branch circuit breakers; three 15 ampere single pole branch circuit breakers; one 30 ampere 3-pole branch circuit breakers; and two 50 ampere, 3-pole branch circuit breakers for the engine block heaters. Provide control power branch circuit conduit and wire connections from CPP to respective engine generator components, including but not limited to; the engine starting battery charger; engine block heaters; fuel monitors and transfer pumps; engine lighting and power systems. The CPP-panel shall be surface mounted on or inside the engine generator, unless indicated otherwise on the Drawings. CCP Mounting height shall not be less than +24-inches above finish grade to panel bottom, or exceed +78 inches above grade to panel top.
2. Provide two 120 volt 20 ampere duplex convenience weatherproof receptacles adjacent to the CPP panel installed in a surface mounted cast metal outlet box. Connect to CPP 20 ampere branch circuit breaker, with 0.5-inch liquid-tight flexible metal conduit with 3#12.
3. Provide sealed and gasketed vapor-proof nonmetallic housing lighting fixtures inside the generator enclosure. Each lighting fixture shall contain two 9 watt or one 13 watt compact fluorescent lamps with internal solid state low temperature electronic lamp ballasts. Provide not less than the following quantity of lighting fixtures, spaced equally within the housing. Connect to CPP panel 15 ampere branch circuit breaker, with 0.5-inch 3#12 liquid tight flexible metal conduit. Provide one S.P.S.T. "on-off" vandal proof lighting control switch in cast metal outlet box.
   a. 200kW and smaller engine generator, quantity of four lighting fixtures.
   b. Over 200kW engine generator, quantity of eight lighting fixtures.

END OF SECTION 263215

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SECTION 263353
UNINTERRUPTIBLE POWER SUPPLY - UPS

PART 1 GENERAL

1.1 WORK INCLUDED:

All labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for an 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:

A. Examine all other Sections for work related to those other Sections and required to be included as work under this Section.

B. General Provisions and Requirements for Electrical Work.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Detailed Shop Drawings including Dimensioned Plans, elevations, details, schematic and point-to-point wiring diagrams and descriptive literature.

B. Submit Transformer Test Reports.

C. System Configuration with Single Line Diagrams, show both internal and external wiring connections on Single Line Diagrams.

D. All Circuit Breakers and Fuses shall be identified by location, frame size, trip rating and Manufacturer with type number, terminal locations and interconnect wiring diagrams. Submit engineered settings for all UPS adjustments, protection devices, time-outs, alarm pickup-dropout, software controls etc.

E. Size and Weight of Individual Shipping Units, weight dimensions and heat dissipation of each unit.

F. Detailed Descriptions of Equipment to be furnished, including all deviations from the Contract Document requirements.

G. Detailed Layouts of all metering, alarm and mimic panels. Monitoring and metering sensing points shall be shown on the single line diagram.

H. Short Circuit, Coordination and Arc-Flash (Additional Requirements)

1. Perform and submit engineered settings for each equipment location, fuse and adjustable circuit breaker device, showing the correct time and current settings to provide the 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

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

1. The complete Uninterruptable Power System assembly; including circuit protection devices, inverters, batteries, housings/enclosures, 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 UPS 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. 100MPH-West Coast States USA, California, and Hawaii.
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.

1.3 GENERAL

A. Description

1. Each Uninterruptible Power Supply (UPS) system shall provide online double conversion, continuous operation, solid state static, uninterruptible electric power supply and distribution. The UPS shall function as an active electrical power source, electrical power conditioning and active control system in conjunction with the following:
   a. The facility normal (utility) incoming services electrical supply source or sources.
   b. The Direct Current (DC) bus UPS input source.
   c. The facility electrical loads connected to the UPS output
2. The UPS shall automatically provide continuity of electric power within specified tolerances to the UPS output loads, without interruption, including during failure or deterioration of the normal input power supply. Continuity of electric power to the load shall be maintained for an emergency time period with the UPS supplied by battery power up to the specified time and during restoration of the normal utility/ generator power supply.
3. The UPS shall provide 100 percent continuous conditioned; uninterrupted electric power of the specified limited duration for any combination of linear and nonlinear UPS output loads shown connected to the UPS.
4. Each UPS shall consist of a converter; DC input bus/charger and battery system; solid state inverters; maintenance bypass transfer circuit; controls and monitoring systems; synchronizing systems; circuit protective devices; operating software, and equipment enclosures.
5. UPS Sold State Electronic Components
   a. Digital-Signal-Processing using Pulse-Width-Modulation (PWM) of all UPS control and monitoring functions. Converter and inverter modules shall use Insulated-Gate Bipolar Transistors (IGBT).
6. UPS shall be suitable and recommended by the Manufacturer for operation on normal utility electrical input power and/or standby engine generator supplied input electrical power.
7. The UPS shall protect and correct the electrical supply to loads connected to the UPS resulting from electrical power failures, power sags, over voltages and power surges, frequency variations, brownouts, bidirectional electrical noise, bidirectional high voltage spikes/lightning, bidirectional switching transients, bidirectional harmonic distortion.
8. UPS internal power supplies for UPS controls and fans shall be redundant “hot-swappable” without affecting or disrupting UPS output loads if one power supply fails or is removed for maintenance. Provide power supply failure alarm.
9. UPS equipment shall all be the product of the same Manufacturer.

a. UPS units, limited to the following pursuant to direction from Owner. As manufactured by Eaton; or APC/Schneider Electric.

B. Standards and Codes

1. The UPS shall be Certified to conform, to be designed and to be manufactured to comply with the following Standards and Codes:
   a. Underwriters Laboratory – UL 1778
   b. Canadian Standards Association – CSA 22.2
   c. International Electrotechnical Committee – IEC Semiconductor Converter Standards
   d. International Organization for Standardization – ISO 9001
   e. California Electrical Code – CEC
   f. Federal Communications Commission – FCC Part 15 Subpart-J, Class-A for conducted and radiated noise
   g. Institute of Electrical and Electronic Engineers – IEEE 587, Category A and B.
   h. National Electrical Manufacturers Associates – NEMA PE-1
   i. American National Standards Institute – ANSI 62.41
   j. EIA/TIA – 568B
   k. Local applicable Standards and Building Codes

PART 2 PRODUCTS

2.1 DESCRIPTION AND OPERATION

A. UPS System Operation

1. The UPS shall operate continuously at described capacity and performances as a continuous on-line automatic system in the following modes to supply rated voltage and kVA output to the UPS connected loads.
2. Modular configuration, providing incremental UPS electrical load and battery capacity expansion of the initial UPS capacity installation.

B. Normal Mode

1. The UPS inverters continuously supplies output to the loads connected to the UPS. Convert the UPS normal input voltage to regulated DC voltage for input to the inverter and simultaneously supply regulated DC as a float charge to the UPS D.C. bus storage batteries.
2. If the DC bus/battery system is disconnected from the UPS for reasons of overload, failure or maintenance of the DC bus/battery system, the UPS shall continue to function and meet all of the specified performance characteristics, for the connected output loads, except the normal input source power outage back-up time capacity for the DC bus/batteries.

C. Emergency Mode

a. Upon failure of the normal input power to the UPS, the inverter shall derive its input from the DC bus UPS battery system and provide continuous uninterruptible power to the loads connected to the UPS output. The transition from UPS normal input power to UPS DC bus battery system shall be accomplished without any switching or coupling and without any interrupting of power to the loads connected to the output of the UPS as a result of either a failure or restoration of the normal input source power to UPS.

D. Recharge Mode

1. Upon restoration of stable nominal normal input power to the UPS, the converter shall automatically reactivate and provide regulated DC voltage for input to the inverter and simultaneously supply regulated DC recharging of the DC bus UPS storage batteries. The recharge process shall occur automatically and without any interruption of the full load output to the loads connected to the UPS.
2. Trickle charge maintain battery recharge with a trickle charge and float charge to full 100 percent battery capacity. Provide equalizing voltage charge to batteries controlled by the UPS control system.

E. Maintenance – Bypass Mode

1. "Make before break internal bypass switch to provide bypass of normal input power around the UPS to the UPS output loads. The maintenance bypass shall provide electric isolation of the UPS from the UPS normal source input power, the D.C. input bus; inverters/chargers; static switch; and the UPS output loads, without any interruption (make before break) of power to the UPS output loads.
2. The maintenance bypass system shall connect the UPS output loads to:
   a. The same UPS normal input power source as the UPS
3. The maintenance bypass system shall automatically insure the bypass input source and load output are synchronized prior to permitting bypass mode operation.
4. The bypass system shall provide for a procedure to electrically and physically isolate the bypass system from the input sources, load output and UPS/inverters – chargers – batteries when the UPS is supplying the output load.
   The isolation shall allow, without any interruption to the output load, inspecting, testing, repair, removal/reinstallation of the maintenance bypass system components, without any possibility of contact with the energized UPS/inverters – charger – batteries and output loads.
5. The UPS/inverters – charger – battery systems shall be electrically isolated and physically separated from the UPS maintenance bypass systems; the input sources; the load output, when the UPS is in the bypass modes. The isolation, without any interruption to the output load, shall allow inspecting, testing, repair, removal/ reinstallation of the bypassed components of the UPS without any possibility of contact with the energized UPS maintenance bypass system components and output loads.

2.2 DEFINITIONS

A. Uninterruptible Power System (UPS) - All components within the UPS module cabinet(s), separate battery cabinet(s), load output and bypass modules which function as a system to provide continuous, conditioned AC power to a load.

B. UPS Module Cabinet - Metal enclosure(s) which contain the rectifier/charger, the inverter, the maintenance bypass switches, the external operator controls, and the internal control system required to provide specified AC power to a load.

C. Battery Cabinet - Metal enclosure(s) which contain maintenance free sealed batteries sufficient to maintain UPS output according with the specifications and a battery disconnect circuit breaker.

D. UPS Module - The rectifier/charger and inverter units which, under the supervision of the internal control system and external operator controls, provide specified AC power to a load.

E. Rectifier/Charger - The UPS component which contains the equipment and controls necessary to convert input AC power to the regulated bus power required for battery charging and for supplying power to the inverter.

F. Inverter - The UPS component that contains the equipment and controls necessary to convert DC bus power from the rectifier/charger or the battery to AC power required by the UPS connected output load.

G. Internal Control System - The signal processing circuits which regulate the power conversion processes, detect fault conditions, and control the sequence of operation of the UPS. This term may be shortened to "control system".

H. Operator Controls - The controls, which are used by the operator to monitor and operate the UPS.

I. Maintenance Bypass – the automatic operation device that connects the UPS output load to the UPS input source when the UPS Module and Bypass cannot supply continuous power.

J. Automatic Bypass Static Transfer Switch - The device, which connects the UPS output load to the static bypass line when the UPS Module cannot supply continuous power.

K. Maintenance Bypass Line - The line, which connects electricity directly from the input power to the UPS connected output load during maintenance or whenever the UPS is not operational.

L. Input Power Source - Power provided by the normal utility power source or auxiliary emergency standby engine generator source, which is connected to the input of the UPS.

2.3 ELECTRICAL PERFORMANCE CHARACTERISTICS

A. General
   1. Grounding:
      a. The UPS output load neutral shall be electrically isolated from the UPS input source neutral, when the UPS is operating in the normal mode.
      b. The UPS shall be provided with equipment ground terminal bus and neutral terminal bus on each incoming source line side and load output side.
      c. Provide for bonding the UPS load output system neutral bus and ground bus to the incoming source line side neutral bus and ground bus when the UPS is in the Bypass Modes.
   2. The UPS shall comply with US Government Agency FCC – Class A RFI requirements for all operating modes.
   3. Input voltages, output voltages, kVA/kW output load rating and phase configurations as shown on the Drawings and specified herein.
   4. UPS - Electrical voltage capacities
      a. UPS normal input source lineside voltage 208/120-volt - 3 phase, 4 wire, 60Hz AC grounded.
      b. UPS Maintenance-Bypass input source line side voltage, 208/120 volt - phase, 4 wire, 60Hz AC grounded.
      c. UPS output load voltage 208/120 volt - 3 phase, 4 wire, 60Hz AC grounded.
      d. Refer to Drawings for additional information.
   5. UPS - Electrical load capacities
      a. UPS initial output full load capacity as indicated on Drawings.
      b. UPS modular full load output future expansion capacity up to additional 150-percent.
   6. UPS - Electrical load operating DC bus battery capacity continuous time duration at full rated output load not less than 30-minutes.

B. UPS Normal Mode Input (Line Side Source) AC Sinewave, for Constant Rated Output
   1. Voltage range tolerance without any DC bus battery discharge or transfer to Bypass Modes: ± 15 percent
   2. 60HZ AC frequency range tolerance without any DC bus battery discharge or transfer to Bypass Modes: ± 5 percent
   3. Reflected input power factor shall never exceed 1.0 (unity) when operating in the Normal Mode or Recharge Mode
      a. At 100 percent load — 0.92 lagging, minimum
      b. At 50 percent load — 0.85 lagging, minimum
      c. When operating in the Bypass Modes the reflected power factor shall track UPS load power factor.
   4. Maximum reflected Total Harmonic Distortion (THD) including UPS load contributions
      a. At 100 percent load — 7 percent
      b. At 50 percent load — 10 percent
      c. When operating in the Bypass Modes the reflected THD shall track the UPS load THD.
   5. Total UPS Efficiency when operating in any mode, including input/output isolation transformer losses:
      a. At 100 percent load — Greater than 92 percent
      b. At 50 percent load — Greater than 89 percent
      c. UPS efficiency shall be the measured output KW divided by the measured input kW; with a connected load power factor of 0.8 lagging and the DC bus batteries fully charged operating on-trickle float charge.
   6. Maximum magnetizing in rush current:
      a. 1.0Hz maximum or less duration – six times normal fullload input current
   7. Input Source Load Limits
      a. The UPS shall limit the total normal source input load of the UPS to a value not to exceed 130 percent of the UPS continuous output kVA full load rating.

b. The input source load limit value shall include the UPS DC battery recharging loads, DC battery trickle charging loads, UPS full steady state rated output loads and the UPS internal operating losses.

C. UPS Output (Load Side) AC Sinewave

The UPS shall comply with the load output electrical characteristics described below, when the UPS is operating in the Normal Mode, Emergency Mode or Recharge Mode. The UPS load output electrical characteristics shall track the UPS input source lineside when the UPS is operating in the Bypass Modes.

1. Dynamic voltage regulations, from 0kVA to full load rating, phase-to-phase or phase-to-neutral.
   a. Balanced loads ± 0.5 percent
   b. Unbalanced loads ± 2 percent
2. Maximum voltage transient response
   a. 20 percent output load step ± 3 percent
   b. 50 percent output load step ± 4 percent
   c. 100 percent output load step ± 5 percent
   d. Loss or return of AC input voltage ± 1 percent
3. Voltage transient recovery time of rated voltage to within 1-percent, less than 1.0Hz.
4. Voltage Total Harmonic Distortion (THD) not including connected load harmonic distortion contribution.
   a. 100 percent linear load 2 percent
   b. 100 percent non-linear load 5 percent
5. Overload capacity while maintaining voltage regulation within ± 2 percent and while maintaining input source load limits.
   a. 125 percent of full load output for 600 seconds.
   b. 150 percent for 30 seconds.
   c. 200 percent for 20 seconds.
   d. 1000 percent for up to 1-Hz.
6. Manual voltage adjustment ± 5 percent
7. Frequency stability for all specified load conditions, DC bus voltage conditions and temperature conditions
   a. Free running for all load conditions, DC bus voltage conditions and temperature conditions: 60Hz ± 0.1% in a 24 hour period; ±1% in a 6 month period
   b. Maximum slew rate 0.1HZ per second
8. Maximum Phase to Phase frequency Displacement (Imbalance)
   a. Balanced loads 120 degrees ± 1 degree
   b. 100 percent unbalanced loads 120 degrees ± 3 degrees
9. Connected load power factor 20 percent lagging to 130 percent leading for nominal UPS output/input operation.
10. Output synchronization:
    a. The UPS output shall stay synchronized with the automatic bypass input source, if no automatic bypass system is present then maintain synchronization with the manual bypass input source line frequency, provided the static bypass input source line remains within the nominal frequency. Where a bypass is not required to be provided with the UPS, the UPS shall stay synchronized with normal input source.
    b. If the input source line frequency goes outside described limits, the inverter shall break synchronization with the input source line and run on the UPS internal reference frequency. When the input source line frequency returns, within described limits, the inverter output shall automatically re-synchronize with the respective input source line.
    c. The UPS shall be provided with a temperature compensated internal oscillator, to automatically maintain the output load voltage frequency when the input source line voltage frequency exceeds specified limits.
    d. The rate of frequency change (slew rate) shall not exceed 0.1Hz per second.

D. Transient Voltage Surge and RFI/EMI Protection – (TVSS)

The UPS shall comply with the transient voltage surge and RFI/EMI electrical characteristics described below, when the UPS is operating in the Normal Mode, Emergency Mode, Recharge Mode or Bypass Modes.

1. Lightning and Transient Voltage Surge Protection, Electromagnetic Interference (EMI), and Radio Frequency Interference (RFI) Noise Filtering shall be provided for each UPS. The protection shall function during all UPS Operating Modes.
2. Provide EACH of the UPS source inputs and the load output of the UPS with lightning protection, transient voltage surge protection and EMI/RFI protection. The protection shall include functions for common mode and transverse mode; line-to-line (phase-to-phase); each line-to-ground (phase-to-ground); each line-to-neutral (phase-to-neutral) and neutral-to-ground connection protection configurations.
3. RFI and EMI
   a. Conducted line noises interference both EMI and RFI shall be reduced by the UPS over a continuous spectrum of 0.5 MHz to 1.0 MHz.
   b. The basis for reduction shall be a standardized 50 OHM insertion loss MIL –STD-220A Test.
   c. Provide spectrum analysis test, dB attenuation reports showing EMI and RFI filtering over specified frequencies. Test data that is based on calculated or computer simulation is not acceptable.
4. Voltage surge protection:
   a. Phase-to-phase and grounded "WYE" performance requirements

Characteristics	208/120 Volt
1) Nominal line to line	208 Volt
2) Nominal line to neutral	120 Volt
3) Internal capacitance Microfarads)	2.5
4) Maximum response time	1-nanosecond
5) Minimum EMI/RFI noise rejection	35-45 DB
6) Nominal peak clamp voltage line to neutral and line to ground	205 volts

   b. Minimum transient energy dissipation per phase (at 8 x 20 microseconds waveform): 1000 joules
   c. Peak transient withstand (at 8 x 20 micro-seconds wave-form) without failure of unit, ANSI C642.41: 50,000 amp
      1) Category-C3: 80,000 amp
      2) Category-B3: 60,000 amp
      3) Category-A3: 50,000 amp

E. UPS Short Circuit Withstand and Interrupt Ratings (bolted short circuit fault conditions, symmetrical and asymmetrical).

1. UPS line side input sources shall be "fully-rated" for the short circuit current available at the respective input sources of the UPS as described below, but in no case less than shown on the Drawings. "Series-Rated" with upstream devices is not acceptable for lineside input source devices:
   - 240 volts line-to-ground and below – 42,000 ampere RMS symmetrical.
2. UPS internal components shall be "Fully-Rated" or "Series-Rated" to the UPS line side input sources and the UPS load side output, but in no case, less than indicated on the Drawings, and not less than indicated in the time-current short circuit study submittal.
3. UPS load side output shall be "Fully Rated" or "Series-Rated" to the UPS line side input sources, but in no case less than indicated on the Drawings.

F. UPS DC Bus (Battery Source)

1. Maximum D.C. ripple with or without batteries connected to the D.C. Bus
   a. Voltage ± 0.4 percent
   b. Current 2 percent RMS
2. Battery voltage shall not vary beyond the following:
   a. Mutual D.C. bus battery shall not exceed 550 volts
3. The D.C. bus battery, end of discharge shutdown, shall be automatically adjusted by the UPS controls for partial UPS output load conditions, to allow for extended operation without damaging the batteries. Automatic shutdown based on discharge time is not acceptable.

4. Battery recharge time from full discharge to 95 percent recharge shall not exceed 15-times the UPS full load Emergency Mode operating time duration, when the UPS Input Source Load Limit is set at 130 percent.
5. An automatic battery equalize voltage charge shall initiate after the UPS returns to Normal Mode from any other operating mode. The override of equalize voltage and the time duration shall be adjustable from the UPS Control System.
6. The D.C. bus battery "float" charging voltage shall be automatically temperature compensated for the battery ambient temperature as monitored by the UPS.
   a. Approximate voltage adjustment range: ± 25 volt
7. UPS Load Testing of D.C. Bus
   a. Manually initiate from the UPS Control System a reduction of the D.C. bus battery charging voltage to approximately 1.9 volts per cell to force the D.C. bus batteries to carry the UPS load for a limited time.
   b. If a drop in battery voltage occurs indicating diminished battery capacity or battery failure, shall automatically cancel the test and "Alarm" the UPS Control System.

2.4 ENVIRONMENTAL OPERATING CONDITIONS (INCLUDING BATTERIES)

A. General
   1. UPS equipment shall maintain a full UPS load and performance without any derating of UPS operation resulting from the ambient conditions described below.

B. Ambient Conditions
   1. Normal ambient operating conditions:
      a. Temperature – 20 degrees to 30 degrees centigrade.
      b. Humidity – 30 percent to 90 percent non-condensing.
   2. Emergency ambient operating conditions:
      a. Temperature 0 degrees to 40 degrees centigrade.
      b. Humidity 5 percent to 95 percent non-condensing.
   3. Non-operating and storage conditions:
      a. Temperature – Minus 20 degrees to positive 50 degrees centigrade.
      b. Humidity – 0 percent to 95 percent

C. Altitude Normal Conditions
   1. Operate from sea level to 5,000 feet above mean sea level without derating.
   2. Non-operating and storage from sea level to 25,000 feet above mean sea level.
   3. Installation location of the UPS exceeding 5000 feet above sea level. The UPS kW and kVA output load ratings and DC Bus battery capacities shall be increased to compensate for the UPS altitude derating recommended by the Manufacturer, to maintain the specified output load capacities of the UPS.

D. Audible Noise
   1. Noise generated by the UPS under any condition of specified operation shall not exceed a sound pressure level measured at 5-feet from the nearest surface of the cabinet as follows:
      a. Shall not exceed 65dBA.

2.5 UPS ELECTRICAL CIRCUIT PROTECTION, DEVICES AND DISCONNECTS

A. Protection against External Events
   1. The UPS system shall incorporate built-in protection to prevent permanent damage to the UPS and to circuits extending external to the UPS for the following:
      a. Overvoltage, under voltage and overcurrent surges introduced by the primary UPS input sources.
      b. Overvoltage and overcurrent surges introduced on the UPS load output terminals by sources in the load, load switching and fault clearings in the distribution system of the load.
      c. RFI and EMF
      d. Transient voltage and lightning surges.

B. Protection against Internal Events

1. The UPS System (including the batteries) shall have built-in protection against permanent damage to itself and the connected load for all predictable types of failures within the UPS.
2. Protective devices shall be provided for power semiconductors, these devices shall be configured to prevent cascading failures.
3. The operation of any protective device shall be detected and displayed by the monitoring diagnostic system of the UPS Control System.

C. Input and Load Output Circuit Protection Devices

1. Device Types 100 Ampere and Greater Rating
   Multipole gang operated; time overcurrent circuit breakers with field adjustable internal solid state trip protection units, providing long time overcurrent/delay, short time overcurrent/delay and instantaneous current, trip element adjustable settings and electrical “shunt-trip” operation. Auxiliary annunciator and pilot relay contacts to indicate when the respective device is “Open-Closed-or Tripped”.
2. Device Types under 100 Ampere Rating
   Same as “100 ampere or greater” requirements or alternately multipole gang operated molded case circuit breakers with fixed non-adjustable thermal-magnetic overcurrent trip elements, adjustable instantaneous trip elements and electrical “shunt-trip” operation. Auxiliary pilot, relay contacts to indicate when the respective devices is “open-closed-or tripped”.
3. Protection devices shall be rated for true RMS voltage operation with loads containing 100 percent THD harmonic voltage content.
4. Main circuit protection devices for UPS lineside input sources and for load side output shall be motor operated, to allow “on-off” switching control of the protection devices by the UPS Control System.

D. Provide a main circuit protection/disconnect device on each line side input source to the UPS and on each load side output of the UPS. Each device shall be rated for the UPS respective circuit, continuous 100 percent load ampere input/output rating.

1. Main normal utility source input.
2. DC bus battery input source.
3. Each feeder/branch circuit load output.
4. Maintenance bypass input source and load output.

E. Output Load Branch Circuit Protection

Provide individual branch circuit feeder load side output circuit protection devices for each load connection to the UPS shown on the Drawings. Each device shall be rated to supply the continuous 100 percent load ampere of the respective connected load without derating.

F. Emergency Power-Off Controls (EPO)

1. The UPS shall be provided with the means of turning off the UPS and disconnecting power to all the UPS input source(s) and the output load both locally and remotely.
   a. Locally - By a single operator switch.
   b. Remote - By the opening of an external customer supplied normally open or normally closed pilot relay contact.
2. Battery fused disconnect switches for manual on-off control of battery output, rated for battery disconnect ampere capacity.
3. UPS equipment “emergency-shutdown” pushbutton key/switch to shut down and disconnect from the UPS all input sources, shut down and disconnect all output loads from the UPS and shut down the entire UPS system. Locate shut down on the UPS equipment.
4. In addition to the UPS “emergency-shutdown” pushbutton located on the UPS, provide a remote UPS “emergency-shutdown” pushbutton for each UPS at each location shown on the Drawings, but in no case less than one remote pushbutton for each UPS, located at each door that provides access into the room occupied by the UPS.

G. Over Temperature Protection

1. Provide internal temperature sensors to monitor temperature of critical UPS components. Upon detection of temperatures in excess of Component Manufacturer's recommended ambient working temperature, the sensors shall cause audible and visual alarms to be indicated on the UPS Control Panel.

2.6 BATTERIES

A. Battery
   1. Storage battery unit(s) shall be furnished for the UPS with sufficient capacity to maintain 100 percent full load operational characteristics and duration in a 25 degree centigrade ambient temperature as specified herein, plus not less than a 5-percent spare reserve capacity.
   2. Battery cell caps shall incorporate hydrogen gas catalytic converter to reduce hydrogen out gassing during battery cycling.
   3. The batteries shall be the maintenance free sealed type.
   4. The battery containers shall be impact-resistant plastic. Each battery shall be designed for a 10-year life, when maintained under UPS full float charge operation as recommended by the Battery Manufacturer.
   5. The batteries shall comply with and be tested per ANSI-N45.2 and MIL-I45208A.
   6. The battery cell containers and covers shall be a flame-retardant material; all cells exceeding 0.25 KW per cell storage capacity shall include an integral flash arrestor.
   7. The battery load circuit connection terminals shall be rated for the UPS D.C. bus, Recharge Mode, Normal Mode and Emergency Mode operating voltage and current.
   8. Battery type:
      a. The battery cells shall be lead-calcium type characteristics, VRLA type.

B. Battery Cabinet
   1. All the cells making up the battery shall be installed in a freestanding cabinet, of the same construction as the UPS module cabinet. Battery shelves shall support and organize the batteries and D.C. wiring inside the battery cabinet. The cabinets shall all be of the same height and depth as the other UPS cabinets.
   2. Each battery cell shall be held in place to prevent movement during seismic event, as required for Seismic Earthquake Restraints at the location of installation.

C. Battery Disconnect Circuit Breaker
   1. Provide each UPS Unit with a DC-battery main circuit breaker. This circuit breaker shall be mounted between the battery output bus and UPS D.C. input bus. When the circuit breaker is open, there shall be no battery voltage present in the UPS module cabinet.
   2. The UPS Module shall be automatically disconnected from the battery by opening a motor operated circuit breaker or contactor, when the battery reaches the minimum discharge voltage level or when signaled by other UPS Control Functions.
   3. Disconnect shall be rated 600 volt D.C. operation, ampere rating equal to D.C. bus ampere rating and not less than 125 percent of the maximum DC Bus ampere flow.

D. All battery wiring shall be 600 volt insulated copper conductors.

2.7 CONTROL AND MONITORING

A. General
   1. All of the operator controls and monitors shall be located on the front of the UPS Module cabinet.
   2. Voltage, current, power, frequency and temperature parameters shall be measured and monitored using true RMS values, within $\pm$ 1 percent accuracy.
   3. Provide an annunciator lamp push-to-test button to test all annunciator lamps and audible alarms.

B. Controls
   1. The startup, shutdown and bypass operations shall be accomplished by a single control switch that will indicate when and in what direction the control switch should be turned.
   2. Pushbuttons shall be provided to display the status of the UPS. Pushbuttons shall also be provided to silence, test, set and reset visual and audio alarms.

C. Instrumentation for UPS Units
   1. The following alphanumeric digital metering/monitoring information shall be monitored and displayed. A high value alarm, low value alarm and pre-alarm set points shall be field programmable for each metering/monitoring value and maintained in non-volatile UPS storage

memory for recall display from memory. Analog to digital converters, current transformers and potential transformers for each instrumentation function shall be provided as part of the UPS system.

2. Each input source and the load output AC-voltage, AC-amperes and total harmonic distortion, line-to-line and line-to-neutral for each phase for:
   a. UPS module.
   b. Each UPS bypass unit.
3. Each input source and the load output-AC power factor, load capacity percentage; AC-frequency, AC-KW and AC kVA for:
   a. UPS module.
   b. Each UPS bypass unit.
4. DC battery bus:
   a. Battery operating capacity and remaining capacity during battery operation.
   b. Total UPS operating time of DC Bus source battery.
   c. DC voltage and ampere.

D. Status and Alarms for UPS Units

1. The following alarms shall be displayed, an audible alarm shall activate when any of the following alarms occur. A visual alphanumeric display or pilot light annunciator shall display each condition. The time, date and duration for each status and alarm shall be maintained in non-volatile UPS storage memory, for recall display from memory. Analog to digital converters, sensors and transponders to sample and monitor each condition shall be provided as part of the UPS system.
2. Power-On, Power-Off and Power-Failed for each input source and load output (AC and DC sources).
3. DC bus
   a. Battery discharging.
   b. Low/high DC Bus voltage.
   c. DC Bus ground fault.
   d. Low battery reserve shutdown.
   e. DC Bus batteries disconnected.
4. UPS loss of synchronization.
5. Temperatures
   a. Equipment over temperature; pre-alarm shutdown.
   b. Over temperature shutdown.
   c. Cooling fan failure.
   d. Battery over/under temperature.
6. UPS Control Power failed.
7. Each source input and load output:
   a. Over, under voltage and loss of voltage.
   b. Over and under frequency.
   c. Overload warning and shutdown.
8. UPS circuit breakers and circuit protection devices disconnect or fuse open.
9. Rectifier/charger failure.
10. Each UPS Bypass Mode:
    a. Load operating on bypass.
    b. Bypass input source not available/disconnected.
    c. Bypass disabled.
    d. Incorrect Bypass phase sequence.
    e. Bypass input source and load output not synchronized.
    f. Bypass disconnected from the load output.

E. Mimic Panel

1. The mimic panel shall depict a single line diagram of the UPS. Indicating lights shall be integrated with the single line diagram to illustrate the status of the UPS Power paths. The functions whose status is to be displayed shall include, but not be limited to, the following:
   a. Each input sources power available.
   b. Output load power available.
   c. Normal operation.

d. Bypass operation.

2.8 EQUIPMENT DETAILS

A. All materials and parts comprising the UPS shall be new, of current Manufacturer, of a high grade and free from all defects and imperfections that may affect UPS correct operation and shall not have been verified in prior service, except as required during factory testing.

B. All active electronic devices shall be solid state. All semiconductor devices shall be hermetically sealed. All control relays shall be dust tight, visible contact position, “socketed” plug-in type.

C. The maximum working voltage, current and “di/dt” of all solid state power components and electronic devices shall not exceed 75 percent of the ratings established by the respective Manufacturer. The operating temperature of solid state component cases shall not be greater than 75 percent of their ratings. Electrolytic capacitors shall be computer grade and be operated at no more than 90 percent of their voltage rating.

D. Wiring
   1. Access holes with removable coverplates shall be provided on the top, bottom and sides of the UPS and battery cabinets for inter-cabinet wiring and customer installation wiring connections.
   2. All bolted connections of bus bars, lugs and cables shall be in accordance with requirements of the National Electric Code and other applicable Standards. All electrical power connections shall be torqued to the required value and marked.
   3. Provide conductor connection lug landings for lineside input sources, load side output and control system conductor connections to the UPS. Quantity and sizes of conductor lug landings to match circuit conductors and ratings shown on the Drawings.
   4. All energized terminals and conductors landing/lugs shall be insulation shielded to ensure that Maintenance Personnel do not inadvertently come into contact with energized parts or terminals.
   5. Wire runs shall be protected in a manner, which separate and isolate power from control wiring. Provisions shall be made in the cabinets to permit installation of input, output, and inter-cabinet cabling, using raceway or conduits.
   6. Bus for AC line/load voltage current and bus for D.C. current shall be copper; maximum 800 ampere per square inch current density based on 100-percent non-linear loading; continuous extruded insulation over bus with removable insulation “boots” at all screw/bolted bus connections. Bolted connections shall employ “spring-lockwashers”. Silver-plating of bus at all connection locations.

E. UPS Cabinet Housing
   1. The UPS shall be contained in NEMA Type I metal enclosures, with key locking hinged metal access doors.
   2. Enclosures exceeding 400 pounds shall be anchored to the floor, held in place to prevent movement during seismic event, as required for Seismic Earthquake Restraints at the location of installation.
   3. The UPS housing shall be suitable for mounting on a concrete floor or carpeted floor.
   4. The UPS shall be structurally reinforced with provisions for hoisting, jacking and forklift handling.
   5. UPS cabinet housing segregation:
      a. Provide separate cabinet(s) for each UPS modules, bypass modules and battery modules for UPS units.
   6. The UPS cabinets shall be cleaned, primed, and painted with the Manufacturer's standard colors.
   7. Adequate forced air ventilation flowing through each UPS cabinet shall be provided to insure that all components are operated within their environmental ratings.
      a. All ventilation fans shall be equipped with “wind- vane” sensors connected to an alarm annunciator on the UPS control system.
      b. Provide removable replaceable air filters on air-cooling, air-intake vents on UPS units with internal cooling fans. Fans shall be redundant operation.

2.9 REMOTE ANNUNCIATOR PANEL

A. General
   1. Provide a self-contained wall mounted remote annunciator panel to provide individual indication of the UPS Status and Alarm conditions.
   2. The annunciator shall be alphanumeric display.
   3. Provide pushbutton to silence the audio alarm with automatic resound.
   4. Annunciator shall be flush or surface mount as indicated on the Drawings.

B. Status and Alarm Conditions
   1. The remote annunciator shall display the same monitoring, status and alarm information for each UPS as the UPS Control System.
   2. The remote annunciator panel shall provide remote control of the UPS from the annunciator panel with operator “password” authorization protection.

2.10 NETWORK COMMUNICATION

A. Communication Interface
   1. The UPS shall communicate with the facility computer/data network. Provide Simple Network Management Protocol (SNMP) latest revisions and Management Information Base Protocol (MIBP) latest revisions. The UPS SNMP Agents shall comply with Internet Engineer Task Force IETF-RFC1628 basic and advanced levels standards, compliant software with multi-user site license. The software shall provide computer data network communication.
   2. UPS internal network interface card shall provide compatible connection to the network installed at the computer data UPS connection location for "inband" network communication.
   3. Provide "out-of-band" communication through RS-232 or USB modem port connection.
   4. Communication ports shall be based on EIA/TIA – 568B Standard connections 100 BASE-T copper wire and multi-mode fiber optic communication links.

B. The software shall operate on each network server and computer workstation node to provide the following monitoring and control functions:
   1. Automatic unattended shut down of multiple network servers and multiple stand-alone systems, to prevent data loss after failure of the normal power source and prior to exhaustion of UPS battery storage capacity. Automatically save all data to hard disk drives.
   2. Automatic reboot of equipment connected to the UPS power outputs, upon restoration of normal utility power.
   3. Notification of normal power loss with broadcast messages to all network connected nodes.
   4. Automatic logging of power events to the network servers and workstations and UPS internal event storage memory.
   5. Software customizable network shut down and auto boot command sequences, with manager password protection.
   6. Provide an internal database of equipment connected to the UPS and provide variable delayed shut down duration of each connected unit.

C. Install and customize the UPS Software on the Network Servers’ workstations, standalone equipment and UPS Equipment Control System.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation of the UPS shall be in full accordance with UPS Manufacturer's recommendations. Set and calibrate all adjustable settings as recommended by the UPS Manufacturer. Install and connect the UPS to the input sources and load output circuits.

B. Transparent temporary protective plastic covers of suitable gauge shall be provided during installation of the UPS System to protect the entire UPS Equipment from dust and dirt at all times, except while working on a given module, after which the plastic covers shall be reinstalled. Remove temporary covers prior to placing UPS in operational service.

C. Anchor the UPS cabinet(s) to the building floor and walls and equipment racks as applicable to hold in place to prevent movement during seismic event, as required for Seismic Earthquake Restraints at the location of installation.

D. UPS Communications

1. Provide complete, copper wire computer data workstation outlet box, and outlet at each UPS location. Provide 0.75 inch conduit with two Category-6A, 4-pair STP twisted pair network data cables complying with EIA/TIA-568B, homerun to nearest computer/data network equipment rack patch panel, or computer data network terminal room closet from each UPS. Provide plug-in RJ-45 connection of UPS to computer data network outlet.
2. Provide outlet box at each UPS and empty 0.75 inch conduit homerun to nearest telephone backboard from each UPS for voice telephone connection to UPS Controls.
3. Provide outlet box at each UPS and two 1.25 inch conduit with conductors recommended by UPS Manufacturer, from UPS to each respective remote UPS Annunciator/Control Panel.
4. Provide outlet box at each UPS and 0.75 inch conduit with 4#14 to each remote EPO.
5. Install, set-up and test UPS Communications Network and Control Software.

3.2 TESTING AND COMMISSIONING

A. General

1. UPS equipment 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.
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 in the UPS 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 Owner's Representative.

B. Provide Full UPS output load capacity and voltage capacity temporary inductive test load banks, 80 percent power factor and perform full load testing of the UPS after the installation is complete and prior to energizing the building system load circuits connected to the UPS. The UPS shall be cycled through two complete charges and discharge cycles with the UPS connected to the temporary load bank. Remove the temporary UPS load bank and complete UPS connections after the successful completion of the UPS Verification and of the UPS Compliance with the Contract Document Testing, Performance Requirements.

C. 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 UPS Operation and 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.
4. Record and document electrical demand load and sequence of operations on the UPS System with all connected loads operating.
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 Owner's Representative Certifying Commissioning has been performed; all respective systems are operating correctly and document all software setup and each device setting.

3.3 FACTORY SERVICE AGREEMENT (FIRST YEAR OPERATION)

A. General

1. Provide site visits and written reports for each UPS 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 visit site and startup-test all UPS Options, Accessories and Functions, Physical, Electrical and Mechanical Inspection. Simulate normal source power outage and recharge functions.
3. UPS factory remote monitoring and reporting of each UPS Status, using LAN-Network and/or telephone communications line provided by the Owner.
4. The Base Contract initial first-year-operation Service Scope shall be renewable, if mutual agreement between the UPS Manufacturer and the Owner is accomplished for service cost, scope and renew.
5. Provide three copies of Factory Service Proposal renew Agreement to the Owner's Representative.

END OF SECTION 263353

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SECTION 265000
LIGHTING FIXTURES

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. General

1. Submit certification letter from Manufacturers of Lamps and Ballasts and Power/Driver Supplies, (or alternately, Manufacturer's published catalog data) stating/showing the specific lamp, ballast, or power/driver supply combination comply with Manufacturer recommendation and approval for the combined use, shown on the Drawings.
2. Provide complete Manufacturers catalog data information for each light fixture (luminaire), ballast, power/driver supplies, lamps, materials, auxiliary equipment/devices, finishes and photometrics.

B. Performance Certification

1. Submit Manufacturer's Certified Test Report data showing compliance with Contract Document.
2. Submit Manufacturer's letter of certification for each fixture type, confirming the proposed combination of specific lamp, ballast, power/driver supply and auxiliary components for each light fixture (luminaire) type will function together correctly and perform in compliance with the requirements of the Contract Documents as follows:
   "The proposed drivers, (where, applicable), lamp sockets and fixture have been tested as an assembly. The proposed fixture products assemblies are certified by the Manufacturer to function within the required temperature, lumen output, electrical characteristics and operational life described in the Contract Documents".

C. Light Fixture Samples

1. If requested by the District's Representative, provide a sample of each fixture proposed as a substitution for a specified fixture. Sample fixture shall be complete with specified lamps, 3-wire grounding "SO" cord and plug for 120-volt 60Hz, AC plug-in operation. Sample fixtures shall be delivered to the District's Representative's Office for review, the samples shall be picked up within 10-working days after review comments have been received; any samples left beyond this time will be discarded by the District's Representative. Decision of District's Representative regarding acceptability of any lighting fixture is final.

1.3 QUALITY ASSURANCE (ADDITIONAL REQUIREMENTS)

A. Work and Materials shall be in full accordance with the latest rules and regulations as follows. The following publications shall be included in the Contract Document 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. UL – Underwriters' Laboratory:
   a. UL – 8750 and 1598C: Light Emitting Diode – LED Equipment for use in Lighting Products and Replacements
2. NEMA – National Electrical Manufactures Association:
   a. NEMA – LE4: Recessed Luminaries Ceiling Compatibility

b. NEMA – SSL #1, #3 and #6: Electronic Drivers for LED; LED and Incandescent Lamp Replacement
c. NEMA – LSD #44, #45, #49 and #51: SSL - Solid State Lighting

3. United States Federal Government:
   a. FCC – Part 18: EMI and RFI emissions limitations.
   b. EPA: Energy conservation publications and waste disposal regulations.
4. ETL and C.B.M. certified and approved.
5. Electrical installation standards, National Electrical Contractors' Association:
   a. NEIS/NECA and IESNA – 500: Recommended Practice for Installing Indoor Commercial Lighting Systems.
   b. NEIS/NECA and IESNA – 501: Recommended Practice for Installing Exterior Lighting Systems
   c. NEIS/NECA and IESNA - 502: Recommended Practice for Installing Industrial Lighting Systems.
6. Illuminating Engineering Society – IES (IESNA):
   a. IES – LM41: Photometric and Reporting.
   b. IES – 587: Transient Surge Protection.
   c. IES – LM79: Solid State Lighting (SSL) Testing and Measurement.
   d. IES – LM80: Testing for Lifetime of LED.
7. ANSI-American National Standards Institute:
   a. ANSI – C81
   b. ANSI – C82
   c. ANSI – C62.41: Transient Withstand
   d. ANSI – C78: Lamps
8. State California Code of Regulations - Title-24: Energy Code

PART 2 PRODUCTS

2.1 GENERAL

A. Complete Fixture
   1. Provide light fixtures complete including lamps, drivers, housings, ceiling and wall trim "rings" for each ceiling type, mounting and adapter support brackets, diffusers/lenses and outlet boxes.
   2. Include an allowance of $300.00 to provide a light fixture for each lighting fixture outlet shown on Drawings without a fixture type designation.

B. Specific Fixture Requirements and Fixture Schedule Information
   1. The catalog numbers included in the description of the various types of lighting fixtures shall be considered to establish the type or class of the fixture with a particular Manufacturer only. The fixture length, number of lamps and lamp types, component materials, accessories, mounting type, ceiling, wall and install adapters, operation voltage, and all other components required to fulfill the total description of the fixture based on all Drawing information, Branch Circuits, Voltages, Specification information, and shall be included in the Contract Requirements regardless of whether or not the catalog number specifically includes these components.
   2. Lighting fixtures shall be the types as indicated in Fixture Schedule on the Drawings and as described in the Specifications.
   3. All fixtures of the same fixture type shall be the same Manufacturer and of identical finish and appearance, unless indicated otherwise on Drawings.

C. Manufacturer Certification of Operation
   1. Lamps and lamp ballasts and power supplies (drivers) shall be recommended and certified by the respective Manufacturer(s), to be "matched" to operate correctly together, within the published characteristics, for efficacy, lamp starting, operating life hours, lumen output, power factor, power input, operating line ampere, sound intensity, and temperature.

2.2 POWER SUPPLIES (DRIVER-POWER SUPPLIES FOR LED-SOLID STATE LAMPS)

A. General

1. All ballast, power supplies, lighting fixtures assemblies and components shall be ANSI, ETL approved C.B.M. Certified and UL labeled.
2. Ballasts shall comply with FCC Part 18 Class-A and NEMA limits as to EMI or RFI and not interferes with normal operation of electrical or electronic data processing equipment.
3. Open circuit voltage, starting voltage, crest voltage and lamp-operating voltage shall comply with requirements of the respective Manufacturer of the installed lamps.
4. Lamp ballasts, power supplies and transformers shall be for use with the specific lamps provided as part of the Contract.
5. Shall be suitable for use with automatic occupancy motion sensing type switching "on-off" control systems, with multiple "on-off" cycles per hour, on a 24-hours a day basis. Operation shall be without loss of performance in operating characteristics described in the Contract Documents.
6. Fusing
   a. Shall be independently fused on the incoming line side within the fixture compartment.
   b. Alternately the Ballast Manufacturer may install the equipment fuse inside the ballast/power supply.
   c. Provide a label next to ballast cover reading: "Ballast (Power Supply) is fused, check fuse prior to relamping". Provide an additional quantity of 10**%** spare fuses and deliver to District's Representative.
7. Ballast sound rating Class-A or better. Where sound-rating classification is not published, the ballast sound rating shall be the best of product manufactured. Ballasts, which are judged by the District's Representative to be excessively noisy, shall be removed and replaced at the Contractor's expense with low noise ballasts.
8. Electronic solid-state ballasts and power supplies shall be the product of Manufacturer that has been producing electronic ballasts/power supplies for a minimum of five consecutive years prior to the date of the Contract.
9. Shall be designed and supplied to operate on the incoming line voltage system circuits to which the respective light fixtures are connected.
10. Shall not contain any PCB (polychlorinated biphenyl).
11. Power factor shall be not less than 0.90, starting and operating. The input starting transient line input ampere should never exceed lamp normal operating ampere by more than 10%.
12. Ballast and power supply disconnect:
    a. Lighting Fixture Manufacturer factory installed and prewired inside each light fixture, for lamp-ballast or lamp-driver power supply.
    b. Shall comply with UL-2459 and CEC/NEC. Shall disconnect (load-break) energized or de-energized ballast/driver from respective line voltage circuit and dimming circuit. UL-94V-0 flame retardant.
    c. Hot pluggable, multi-pole, insulated connectors, with strain relief and finger-safe squeeze-to-release latching function.
    d. Suitable for available voltage and ampere dimming and non-dimming lamp-ballasts and lamp-power supplies.
13. Ballast and power supplies as manufactured by General Electric, Advance, Philips, Universal, Sylvania/Osram or equal.

2.3 LIGHT FIXTURES (LUMINAIRES)

A. General

1. Lighting fixtures shall have all parts, ballasts, sockets, support attachments, trim flanges and fittings necessary to complete and properly install the fixture at the indicated installation locations. All fixtures shall be provided with lamps of size and type specified.
2. Ceiling and/or wall surface mounted lighting fixtures shall not have any exposed chase nipples or conduit knockouts visible to view within fixture housing. Lighting fixtures mounted in continuous rows shall have chase nipples or conduit knockouts between lighting fixture housing, but shall not have visible chase nipples/conduit knockouts on the visible ends of the continuous row of lighting fixtures.

3. Where fixture color is indicated to be selected by the Architect and/or District's Representative, provide two color chip samples for each color for review.
4. Recessed fixtures with attached junction box shall be provided with a junction box permanently attached to the plaster ring so that the junction box is accessible through the fixture opening when the fixture is removed. Connection between fixture and pull box shall be flexible metal conduit with not less than 16 AWG "AF" or "CF" type fixture rated copper wires, high temperature wire insulation for not less than 600 volts AC. The flexible conduit shall be sufficient length, so that when the fixture is removed, the pullbox is readily accessible.
5. Recessed fixtures shall be Underwriters' Laboratory approved for recessed installation with plaster frame and attached pull box. Lamp enclosure, reflectors and finish wiring shall not be installed until plastering is completed. Exposed finish trim shall not be installed until finish painting of the adjacent surface is completed.
6. The fixture shall bear Underwriters' Laboratory label of approval for the wattage and installation indicated.
7. Light fixtures installed outdoors, in damp or wet locations shall be UL labeled for said location as "damp-location" and "wet-location" for the respective installation location.
8. Fixtures in contact with thermal/building insulation shall be UL listed and rated for direct contact installation in thermal insulation systems.
9. Lamp auxiliary support brackets shall be heat-resistant, non-dielectric. Alternatively, metal auxiliary lamp support brackets shall be electrically isolated from the fixture, to prevent glass decomposition.
10. Lighting fixtures installed in masonry and/or concrete construction. The fixture housing shall be rated for "concrete-pour" installation location.
11. Provide a permanent label inside each light fixture stating the following relamping information. Not less than 0.125-inch high black alphanumeric characters on white background.
    "Replacement lamp(s) installed in this light fixture must comply with the following criteria:
    *: CRI *: Lamp Watts
    *: CCT-K *: Lamp Lumens
    Only lamp rated * type lamp ballast shall be installed in this fixture."
    *Insert the value required for the specific lamp required by the Contract Documents for each light fixture.

B. Lens and Diffusers
1. Acrylic plastic or Plexiglas for the light fixture diffusers or fixture lenses shall be 100% virgin material.
2. Thickness of not less than 0.125-inch, as measured at the "THINIST" portion on the diffuser or lens. However, thickness shall be increased to sufficient construction and camber to prevent the lens and diffusers from having any noticeable sag over the entire normal life of the installation.
3. Diffusers shall be formed from cast sheet by a vacuum and/or pressure technique.
4. Lighting fixtures containing lamps with dichroic reflectors and light fixtures with non-dichroic lens/diffuser shall be rated for high temperature lamp operations resulting from lamp heat redirected (reflected) back into the fixture.

2.4 SOLID STATE LIGHTING (SSL), LIGHT EMITTING DIODES (LED) LAMPS, POWER SUPPLIES, AND LIGHT FIXTURES (ADDITIONAL REQUIREMENTS)

A. General
1. Solid State LED light source (lamps), related control equipment (driver-power supply), and luminaire (light fixture) optics for light output distribution.
2. Shall comply with the US-DOE Energy Star Program for SSL-LED. Submit documentation with Shop Drawings.
3. Shall comply with the latest revision IESNA LM-79 and LM-80. Submit documentation with Shop Drawings.
4. SSL chromaticity shall comply with latest revision NEMA and ANSI – C78.377. Submit documentation with Shop Drawings.
5. Submit with Shop Drawings two samples of each light fixture type employing SSL, with prewired 120 volt, 60Hz AC "SO" cord and plug-in cap.

B. LED Lamps
   1. Lamp lumen output and overall efficiency shall be based on the LED lamps installed in specified fixture and ambient operating temperature.
   2. Lamp Color Rendition Index (CRI) shall equal or exceed CRI – 80, unless noted otherwise on Drawings.
   3. Lamp color output shall be 4000-degree K (± 100K), unless noted otherwise on Drawings.
   4. CRI and lamp color temperature shall be same for all light fixtures of the same fixture type.

C. LED Power Supply (Driver)
   1. Combination of power supply and SSL – lamp shall be tested and certified by respective Manufacturers for performance and proper operation.
   2. Provide dimming type driver where indicated on Drawings. Driver and dimming equipment shall be Tested and Certified by respective Manufacturers for performance and proper operation.

D. Self-Contained LED Lamp and Driver, Integral “Screw-Base” and/or “Pin-Connect”, replacement assembly for incandescent lamps.
   1. Shall be dimmable. Dimmer and lamp shall be certified by respective Manufacturers for compatible correct operation with each other.
   2. Optical system and operating temperature thermal performance shall be compatible with light fixture.
   3. Comply with latest revisions of NEMA LSD-49 and SSL-6.

2.5 EMERGENCY BALLAST LIGHTING AND EMERGENCY DRIVER LIGHTING

A. General
   1. Self-contained emergency ballast and power supply (driver) containing batteries, battery charger, solid-state electronic control and lamp/ballast/driver operation, contained within a metal case, red finish case color.
   2. UL–924, listed Emergency Lighting and Power Equipment, for installation inside and/or attached to lighting fixtures.
   3. The emergency battery supply unit(s) shall be provided inside each respective emergency light fixture by the Fixture Manufacturer.
   4. Normal operating temperature range from 0-degrees Centigrade up to operating ambient temperature inside respective lighting fixture, but not less than 50-degress Centigrade.
   5. Provide a permanent label inside each emergency light fixture stating as follows, not less than 0.125-inch high black alphanumeric characters on a white background:
      "Warning – this fixture provides more than one electric power source. Disconnect both normal and emergency sources including battery sources prior to opening fixture. Written permanent records documenting regular (every 30 days) emergency lighting function testing results shall be kept on file by the District."
   6. UL and Manufacturer rated to supply the lamp and ballast/driver (power-supply) combination occurring in the respective light fixture, both dimming-type and non-dimming type light fixtures.
   7. As manufactured by Bodine Inc. or IOTA-Engineering Inc.

B. Operation
   1. Emergency mode
      When external AC electrical power fails, the emergency unit shall immediately and automatically switch to emergency mode. Maintain emergency lamp(s) illumination, while operating from the internal battery/electronics during the power failure for not less than 90-minutes continuous duration.
   2. Normal Mode
      When AC electrical power is restored, automatically switch lamp(s) operation to external AC operation and begin battery-charging mode.
   3. Battery Recharge Mode
      The battery charger shall automatically fully recharge discharged batteries in less than 24-hours, and prevent overcharging of the batteries, while maintaining a "float-charge" on the batteries.

4. The emergency battery unit shall operate not less than two lamps in multi-lamp light fixtures and one lamp in single lamp light fixtures. When operating in emergency mode and battery power, the lamp lumen output of each lamp shall be not less than 40% of the lamp normal full lumen output rating of the lamp operation on normal power. The lamp-lumen output shall be 100% of the lamp normal full lumen output rating when operating in normal mode.
5. The emergency ballast shall provide cold-strike start and hot-restrike operation of the fixture lamp(s).
6. Periodic automatic, internal self-test, simulating normal power loss and actual operation of emergency lamps on internal battery power. Auto self-test shall occur not more than 30-day intervals. Audible and visual trouble alarm display, with manual alarm reset/silence, for problems identified by auto-test functions.

C. Electrical Characteristics
1. Emergency equipment shall operate on the same input AC voltage as the normally "hot" branch circuit supplying the respective light fixture. Maximum line input load shall not exceed 15% more than normal fixture electrical load.
2. The emergency equipment shall be compatible for correct operation with the specific lamp/ ballast/driver combination contained in the respective light fixture.
3. The emergency equipment shall be compatible with switched (on-off), non-switched (continuously on) and dimmer controlled lighting fixtures/circuits.

D. Components
1. Sealed nickel cadmium batteries, maintenance-free, rated for continuous operation in high ambient temperature, with 7 to 10 year operational life expectancy.
2. When standing on the floor below the fixture the emergency ballast test/monitor control panel shall be visible and readily accessible when the fixture is installed. The control panel shall provide:
   a. Charging indicator visual annunciator to display the charger and battery status.
   b. Momentary test switch/pushbutton to manually simulate power failure test.

PART 3 EXECUTION

3.1 LIGHT FIXTURE INSTALLATION

A. General
1. The Contractor shall verify actual ceiling and wall construction types as defined on the Architectural Drawings and furnish all lighting fixtures with the correct mounting devices, trim rings, brackets whether or not such variations are indicated by fixture catalog number. The Contractor shall verify depth of all recessed lighting fixtures with Architectural Drawings prior to ordering fixtures. Any discrepancies that would cause recessed lighting fixtures not to fit into ceiling shall be reported to the District's Representative prior to release of order to the Supplier of the fixtures.
2. On acoustical tile ceilings, fixture outlets shall be accurately located in the center, at the intersection of the four corners or at the center of the joints of two tiles.
3. The Contractor shall aim the exterior adjustable lighting fixtures after dark in the presence of, and at a time convenient to the District's Representative.
4. Fixtures shall be ordered and furnished to operate correctly on the branch circuit voltage connected to the respective fixture as shown on the Site Plan and Floor Plan Electrical Drawings. The voltages shown on the fixture schedule are for generic fixture information only.
5. Install and connect lighting fixtures to the circuits and control sequences indicated on the Drawings and to comply with respective Manufacturer's instructions/recommendations.
6. Lighting fixtures in building interstitial spaces, in mechanical plumbing and electrical spaces/ rooms, are shown in their approximate locations. Do not install lighting outlets or light fixtures until the mechanical, plumbing and electrical equipment/pipes/ductwork are installed; then adjust and install lighting in revised clear (non-interfering) locations to provide best even-illumination. Coordinate the locations with all other trades prior to lighting installation.

B. Lighting Fixtures Installed in Ceiling Support Grids - Suspended Lay-in "T-bar" and Concealed Spline Ceilings.

1. Provide two seismic clips at opposite ends of each recessed light fixture, the clip shall connect to the ceiling grid main runners and the light fixture. The light fixture with seismic clips and ceiling grid runner connections shall resist a horizontal seismic force equal to the total weight of the light fixture assembly.
2. Each light fixture weighing 40-pounds or less and where the respective ceiling grid system is "heavy duty" type, shall be suspended directly from the ceiling grid or shall be suspended independent of the ceiling grid support system as approved by the AHJ. Each light fixture weighing more than 40-pounds or where the ceiling grid system is not a "heavy duty" type shall be supported independent of the ceiling grid and independent of ceiling grid support system.
3. Each light fixture supported independent of the ceiling grid system shall be supported with a minimum of four taut independent support wires, one wire at each fixture corner.
4. Each light fixture supported directly from the ceiling grid or ceiling grid support system shall be additionally connected with a minimum of two independent slack safety support wires. One wire at each opposite diagonal fixture corner. Each 3-feet by 3-feet and larger light fixture shall be supported in the same manner, except provide a minimum of four independent slack safety wires, one at each fixture corner.
5. Light fixtures surface mounted to a suspended ceiling shall be installed with a 1½-inch steel – "C" channel which spans across and above a minimum of two parallel main ceiling grid "runners" and concealed above the ceiling. Each channel or angle member shall be provided with a minimum of two threaded studs for attaching to the fixture housing through the lay-in ceiling tile. Two steel "C" channel members shall be installed for each 4-feet (or smaller) fixture. Install the channels within 6-inches of each end of the light fixture to span a minimum of two ceiling grid parallel main runners. Provide two seismic clips connecting the ceiling grid main runners to each steel – "C" channel. Provide a not less than two taut independent support wires connecting to each channel. Bolt the light fixtures to the threaded studs on the channels or angles, to support the light fixture tight to the ceiling surface.

C. Fixture Supports

1. The support wires for light fixture support shall be 12-gauge steel (minimum). The wires including their building and light fixture attachments shall provide support capacity of not less than four times the weight of the light fixture assembly. Provide additional light fixture support wires and building anchors to meet these requirements, as part of the Contract. The support wires shall be anchored to the building structural elements above the ceiling.
2. Pendant mounting fixtures shall be supplied with swivel hangers. Fixtures shall swing in any direction a minimum of 45 degrees of gravity, position. Fixtures shall have special stem lengths to give the mounting height indicated on the Drawings. Stem to be single continuous piece without coupling, and to be finished the same color as the canopy and the fixture, unless otherwise noted. The Contractor shall check all lock nuts and set screws to rigidly secure the swivel socket to the stem, and the stem to the outlet box.
   Fixtures shall be plumb and vertical. Where obstructions occur restricting 45-degrees free-swing of fixtures, the fixtures shall be "guy" wired to prevent fixtures from striking obstructions. The District's Representative shall approve method of guying. Swinging fixtures shall have an additional safety hanger cable attached to the structure and the fixture at each support, with the capacity of supporting four times the vertical weight of the light fixture assembly.
3. Suspended fixtures weighing in excess of 40-pounds shall be supported independently of the fixture outlet box. Provide "air craft" (minimum 12 gauge) steel hanger cable for suspended fixtures route cable concealed or in pendant where possible. Each cable attachments shall support four times the weight of the fixture assembly. Securely attach the cable to the building structure.
4. Surface mounted fixtures installed on drywall or plaster ceilings and weighing less than 40-pounds may be supported from outlet box. Provide structural supports above drywall or plaster ceilings for installation of fixtures weighing more than 40-pounds and secure fixture to structural supports. The use of toggle bolts is prohibited.

C. Recessed Lighting Fixtures - Fire Rated Building Surfaces

1. Lighting fixtures recessed in ceiling or wall which has a fire resistive rating of 1-hour or more shall be enclosed in a fully enclosed backbox (except over fixture lens/diffuser). The material

used to fabricate the "enclosed backbox" shall have a fire rating equal to that of the respective ceiling or wall.
2. The space from the fixture to the box enclosure shall be a minimum of 3-inches.
3. The backbox shall be concealed behind the fire rated ceiling and wall finish surface. The light fixture shall be provided with lamp ballast rated for (normal light output) operation in a "high" ambient temperature.

3.2 LENS AND DIFFUSERS

Lens, diffusers, internal reflectors shall be completely cleaned of all dust, dirt and fingerprints after the installation of the light fixtures and lamps, and after all trades have completed work and prior to occupancy of the facility by the DISTRICT.

3.3 COMMISSIONING LIGHTING FIXTURES (ADDITIONAL REQUIREMENTS)

A. General
1. Verify correct lighting control configurations and operation in each room.
2. Simulate normal source power failure by "opening" (turn off) building main service disconnect and verify connections and operation of each emergency lighting fixture.
3. Confirm "EXIT" sign directional arrows are visible in each "EXIT" sign.
4. Verify light fixture support-hangers, ceiling grid clips and seismic restraints comply with the Contract Documents.
5. Remove protective shipping/installation shields on fixtures. Verify fixtures and lamps are clean and free of construction debris. Clean light fixtures found to be contaminated or dirty.
6. Setup, program, and function test lighting control systems to perform each of the indicated control functions, area/room zones and sequences.
7. Provide “aiming”, directional adjustment of light fixtures, both indoor and outdoor. Aiming shall comply with Manufacturer’s aiming diagrams, and as directed by District’s Representative.

B. Sample Spot-Check in each room the following lighting fixture information:
1. Lamp type and performance data.
2. Ballast type and performance data.
3. Combined Lamp/Ballast Certification of performance and compatibility by respective Manufacturer.
4. Verify instructional signage is placed inside each lighting fixture in compliance with Contract Documents.

END OF SECTION 265000
070317/1010006

SECTION 266000
LABORATORY ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The general conditions, Division 1, and Division 26 electrical requirements are part of this section and the contract for this work and apply to this section as fully as if repeated herein.

B. Reference to other sections: The applicable requirements from all other Division 26 sections shall form a part of the electrical work and each section shall be thoroughly reviewed by the Contractor for application to all other sections. For Laboratory areas only (excluding lab lighting), this section shall take precedence.

C. Provide complete electrical systems from the laboratory branch circuit panelboards to all devices and equipment as described in these specifications and shown on the Laboratory Electrical drawings. Electrical installations shall include all required hardware, fittings, boxes, mounting provisions and miscellaneous equipment to provide complete and operable systems in accordance with the standard practices of the trade. Materials utilized shall be as defined in other sections of Division 26 of these specifications and modified only as described herein.

1.2 EXPLANATION OF DRAWINGS

A. The Laboratory Electrical (LE) construction documents are intended to be diagrammatic and reflect the scope, quality, and character of the work to be performed; all miscellaneous materials and work required for a complete and operational system, though not specifically mentioned, shall be furnished and installed by the Contractor.

B. The Contractor shall confirm sizes, dimensions, weights and locations of all devices, light fixtures, and equipment prior to installation. Dimensioned architectural drawings shall take precedence over diagrammatic layouts shown on these contract documents.

C. The Contractor shall be responsible for reporting any discrepancies, errors, or omissions regarding the Laboratory Electrical drawings noted prior to bid.

D. It is the intent of the drawings to indicate schematic routing and placement of devices, fixtures, equipment and conduit. Exact locations shall be dimensioned on other trade documents (architectural, laboratory furnishings, mechanical, etc.). Offsets, elbows, or extensions shall be furnished and installed by the Contractor as necessary to avoid structure, piping, clearances and to provide a complete and workmanlike installation.

1.3 QUALITY ASSURANCE AND STANDARDS

A. All work, material or equipment shall comply with the codes, ordinances and regulations of the local government having jurisdiction, including the regulations of serving utilities and any participating government agencies having jurisdiction.

B. All electrical work shall comply with the latest edition under enforcement, including all amendments, modifications, and supplements, of the following codes and standards or other regulations which may apply:

1. American Disabilities Act (ADA)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Institute of Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronics Engineers (IEEE)
6. Local Code Enforcement Agency Requirements
7. National Electrical Code (NEC)
8. National Electrical Contractor's Association (NECA)

9. National Electrical Manufacturer's Association (NEMA)
10. National Electrical Testing Association (NETA)
11. National Fire Protection Association (NFPA)
12. Underwriters' Laboratories, Inc. (UL)
13. International Building Code (IBC)

No requirement of these drawings and specifications shall be construed to void any of the provisions of the above standards. Any conflicts or changes required to the contract documents in order to obtain compliance with applicable codes shall be brought to the immediate attention of the Engineer, Architect, and Owner's Representative by the Contractor.

C. All items shall be listed by Underwriter's Laboratories and shall bear the U.L. label.

D. Equipment shown to scale is approximate only and based upon a general class of equipment specified. The Contractor shall verify all dimensions and clearances prior to commencement of work.

E. The Contractor shall verify all points of connection with the manufacturer's requirements, instructions, or recommendations prior to installation. The actual dimensions, weights, clearance requirements and installation requirements shall be verified and coordinated by the Contractor.

1.4 SUBMITTALS

A. Shop drawings for materials, equipment, devices, fixtures, and systems shall be submitted by the Contractor for review in compliance with the requirements of Division 1 and Division 26.

B. The Contractor shall bear the responsibility for any materials installed which were not submitted for review or not installed in compliance with the review comments and the contract documents.

C. Verbal modification of submittal documents or changes to the requirements of the contract documents shall not be acceptable. All submittal material must be documented in a written format.

D. All submittal packages must be submitted at one time and in accordance with the specification section appropriate for the material. All packages must be identical and clearly labeled indicating the specification section, project name, submittal date, Contractor's name, Engineer's name, preparer's name and submission version (first submission, resubmittal #1, etc.)

E. Product catalog cutsheets and descriptive literature shall be cross-referenced to the specification section by paragraph.

F. All submittal packages shall be permanently bound in brochure or booklet format. A minimum of six submittal booklets shall be provided by the Contractor; additional copies may be required if so noted.

G. Materials which bear a certification or approval of a testing agency, performance criteria, society, agency, of other organization shall be submitted with all labels identified.

H. The submittal shall be complete and with catalog data and information properly marked to show, among other things, materials, capacity and performance data to meet the specified requirements.

I. Incomplete submittals will be rejected at the discretion of the reviewing Engineer.

J. Review of the submittal is for general conformance with the contract documents. The Contractor is responsible for confirmation and coordination of dimensions, quantities, sizes, fabrication, installation methods, and for coordination of work of other trades with the electrical work.

K. Submittal brochures shall be complete and descriptive of the type, make, manufacturer, application, quantity, performance, capacity, ratings, options, dimensions, clearances, weights, nameplate data, special installation requirements, mounting method, NEMA type, NEMA class, environmental restrictions, layout requirements or other information as may be necessary for review of the material.

L. The Contractor shall be responsible for all aspects of substitutions of material including any additional cost or delay incurred as a result of the substitution. The Contractor shall coordinate all substitutions with other trades, verify code compliance, verify clearances, photometric performance, appearance,

suitability, constructability, and availability of the material prior to submitting the substitution for review. The Contractor shall bear the responsibility of any increased costs to other trades which are directly related to the substitution.

M. Submittals shall include the following:
   1. Raceways
   2. Wire and Cable
   3. Boxes
   4. Wiring Devices
   5. Disconnect Switches

N. Submit detailed dimensioned drawings for all multi-outlet surface raceways.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials shall be new, of prime quality, listed as suitable for the application, and bear factory-applied U.L. labels.

B. Materials shall be currently in production and shall be supported by spare parts, repair service, maintenance, and factory technical support

2.2 RACEWAYS

A. Electrical Metallic Tubing (EMT)
   1. Conduit shall be cold rolled zinc coated steel and manufactured per UL and ANSI requirements.
   2. Fittings for EMT shall be watertight steel or malleable gripping ring compression type.
   3. Pressure cast material for nuts of compression ring type fittings and set-screw connections are not acceptable.
   4. Minimum raceway size shall be ¾".

B. Flexible Metallic Conduit
   1. Flexible conduit shall bear the UL label and be zinc-coated steel.
   2. Fittings for flexible metallic conduit shall be steel or malleable iron. Fittings shall clamp to conduit securely.
   3. Screw in type, sheet metal or set-screw type fittings are not acceptable.
   4. Minimum raceway size shall be ¾".

C. Liquid Tight Flexible Conduit
   1. Conduit shall be manufactured in accordance with UL and ANSI requirements. Conduit shall be approved for grounding and compatible with approved fittings. Flexible steel conduit shall be hot dipped galvanized with extruded PVC covering manufactured per UL requirements.
   2. Fittings shall be liquid tight type with body and gland nut of steel or malleable iron with provisions for grounding flexible conduit to fittings.
   3. Minimum raceway size shall be ¾".

D. Polyvinyl Chloride (PVC) Conduit
   1. PVC shall be constructed of a virgin homopolymer PVC compound and be manufactured according to NEMA and UL specifications. PVC conduit shall be Schedule 40 or 80.
   2. Minimum raceway size shall be ¾".

E. Multi-outlet Surface Raceways
   1. Multi-outlet surface raceways shall be furnished complete with bases, covers, end plates, connectors, wiring devices, receptacles, connectors, and labels as indicated on the drawings and in these specifications. The multi-outlet surface raceways may be factory or field assembled.
   2. Mounting of multi-outlet surface raceways shall be according to the manufacturer's recommendations and detailed drawings. Specific fitting of the multi-outlet surface raceways to

casework, benches, or walls shall be the responsibility of the Contractor. Coordinate elevations with Laboratory Furnishings drawings and details.

3. Refer to the Laboratory Furnishings drawings and specifications for details in regard to the location, length, and quantity of multi-outlet surface raceways.
4. Multi-outlet surface raceways shall fit the intended space with no more than 1/8 inch clearance between each end of the raceway and the adjacent wall, bench, support riser, end of counter, or other laboratory finish as appropriate.
5. Final multi-outlet surface raceway cuts shall be plumb and straight and shall be finished to eliminate burrs, nicks, or sharp edges on both raceways and covers. Multi-outlet surface raceway field cuts which are not equal to the quality and appearance of the factory cuts will be rejected at the discretion of the Laboratory Engineer or Architect.
6. Provide end plates with conduit knock-outs for the conduit sizes indicated or as required by code.
7. All receptacles in multi-outlet surface raceways shall be wired for the entire length of the raceway section with properly tagged pigtails.
8. The multi-outlet surface raceways shall be U.L. listed assemblies.
9. Multi-outlet surface raceway bases, covers, and end plates shall be constructed of extruded aluminum with 0.094" minimum thickness walls and clear anodized finish. The multi-outlet surface raceway extrusion shall be rectangular in cross section and have no protrusions.
    a. Dual channel raceways shall be two compartment, factory pre-wired Wiremold AL4520 series, Monosystems SWA 4800 series, or equal. A continuous, permanently installed metallic barrier shall separate the compartments.
    b. Single channel raceways shall be one compartment, pre-wired Wiremold ALA3800 series, Monosystems SWA 3200 series, or equal.
10. Multi-outlet surface raceway covers shall be cut in 12-inch sections with one “filler” section of less than 12 inches at only one end of each run of raceway as required. Receptacle or telecommunications port locations shall only be provided on a 12-inch cover section.
11. Do not scale or dimension Laboratory Electrical drawings to determine raceway lengths. Laboratory Furnishings drawings should be used for this purpose.
12. Provide labeling with panel and circuit number at each receptacle installed in the raceway. Labels may be either engraved phenolic affixed with epoxy, or engraved directly on raceway cover plate. Phenolic labels shall be block with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.3 WIRE AND CABLE

A. Conductors shall be copper; conductors size #10AWG and smaller shall be solid, conductors size #8AWG and larger shall be stranded. Conductors shall be minimum size #12AWG for power and lighting circuits; control circuits shall use a minimum conductor size of #14AWG.

B. Insulation shall be type THW or THHN/THWN for all branch circuits up to and including size #2AWG. Insulation for conductors over size #2AWG shall be XHHW.

C. Jackets shall be nylon or PVC material.

D. All cables shall be UL listed for the application.

E. All conductors shall be installed in conduit in the field, unless specifically noted otherwise in these documents. Type AC, type NM and type MC cable are not acceptable.

F. Multi-conductor flexible cords shall be types SO, SJO, STO, or SJTO.

G. Connectors shall be UL listed and suitable for the conductor material being connected and rated appropriately. Connectors shall be solderless helical metal spring pressure type or solderless finger metal spring barb type for conductors #10AWG and smaller. Connectors shall be compression type for conductors #8AWG and larger.

2.4 BOXES

A. Boxes shall be flat rolled steel sized as required by code and as suitable for the application. Boxes shall have mounting holes and knock-outs in sides and back. Grounding shall be accommodated by means of threaded holes.

B. Provide accessories, extension rings, gaskets, supports, trim rings, hangers, straps, and other material as necessary for a complete code complying installation.

C. Boxes installed outdoors shall be weather-tight, dust-tight, and corrosion resistant. Provide gaskets and conduit hubs.

D. Provide Type FS boxes for surface mounted applications.

E. Provide additional support for boxes as necessary when mounting fixtures or devices from boxes.

F. Provide ganged boxes for multiple switches and devices; provide barriers for boxes served by separate voltages.

2.5 WIRING DEVICES

A. Receptacles
   1. Wiring devices shall be UL listed and suitable for the application.
   2. Devices shall be color coded per the system to which they are connected: normal power shall be white; standby or emergency power shall be red; dedicated outlets shall be grey; unless otherwise noted on the construction documents.
   3. Receptacles shall be heavy duty, screw type, side wired, 120V, 20A, duplex type, unless noted otherwise on the construction documents. Verify NEMA configuration with construction documents.
   4. Weathertight receptacles shall be gasketed in cast metal boxes with cast metal coverplates with spring-loaded hinged covers over each opening.
   5. Ground fault interrupting receptacles shall be duplex type and capable of detecting a leaking current of 5mA.

B. Toggle Switches
   1. Toggle wall switches shall be quiet AC type, rated 120/277V, 20A and UL listed for the application.
   2. Switches shall be single pole, double throw with white finish unless noted otherwise.

C. Coverplates
   1. Single, combination coverplates shall be used at all ganged device locations.
   2. Provide stainless steel coverplates with matching screws in laboratory, process, manufacturing, and clean room areas or as noted on the construction documents.
   3. Provide labeling with panel and circuit number at each receptacle coverplate. Labels may be either engraved phenolic affixed with epoxy, or direct factory engraving on the coverplate. Phenolic labels shall be block with white lettering for normal power receptacles and red with white lettering for standby or emergency power receptacles. Engraved cover plate labels shall have black lettering for normal power receptacles or red lettering for standby or emergency power receptacles.

2.6 POWER AND TELECOMMUNICATIONS PEDESTALS

A. Manufacturer
   1. Design is based on WaterSaver pedestal electrical box with 3/4” hub, single-gang catalog number E300SA, two-gang catalog number E400SA and E500SA, and four-gang catalog number E600SA.
   2. If alternate product is to be submitted, all material and functional requirements of the specified product must be demonstrated and documented to be equal.

B. Pedestals shall have aluminum base and housing, containing devices as shown on drawings. Housing finish shall be brushed.

C. Faceplates
   1. Pedestal receptacle faceplates shall be stainless steel, and shall accommodate the device types and quantities indicated on the drawings. Faceplates shall have engraved labeling with requirements as noted for raceway and coverplate labels.
   2. Pedestal telecommunication faceplates shall be stainless steel, and shall be provided with cutouts specifically designed to accommodate the type of tel/data devices to be installed by the telecommunications/data system installer. Coordinate prior to ordering faceplates.

2.7 DISCONNECT SWITCHES

A. Disconnects shall NEMA 1, indoor type, or rated for the locations in which they are installed as noted on the construction documents.

B. Disconnects shall be UL listed and suitable for the application.

C. Disconnects in exterior, wet, cold, warm, or hot environments shall be raintight, have raintight hubs, and be rated NEMA 3R.

D. Disconnects shall be heavy duty type, rated 600V with current capacity as noted on the construction documents. Verify NEMA configuration with construction documents.

E. Disconnects shall have hinged, lockable, dead-front doors with permanently marked ON/OFF indicators. Enclosures shall be baked enamel factory painted steel with conduit knockouts.

F. Disconnects shall be operated by a handle accessible from the exterior of the enclosure. Handles shall have provision to be padlocked in the OFF position.

G. All current carrying parts shall be high conductivity copper designed to carry rated load without damage from heat and plated to resist corrosion.

H. Switch mechanism shall be a quick-make, quick-break type such that the operation of the contact is restrained by the handle during the closing or opening operation.

I. Switches shall have a minimum fault current rating of 200,000A RMS.

J. All switches shall be fused unless specifically noted otherwise.

K. The disconnect door cover shall have an interlocking mechanism to prevent opening the cover when the switch is in the ON position.

L. Fuses serving motor loads shall be Class L and Class RK1, 250V and 600V, time delay, dual element unless noted otherwise on the construction documents.

M. Fuses serving non-motor loads shall be Class L and Class RK1, 250V and 600V, fast acting, dual element unless noted otherwise on the construction documents.

N. Provide built-in fuse pullers.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. All laboratory electrical work shall conform to National Electrical Contractors Association standards of installation and the requirements of the manufacturer, Division 1, Division 26, and the Owner's Representative.

B. The Contractor shall field-verify all dimensions and coordinate dimensions with equipment sizes and locations.

C. The Contractor shall coordinate and install all penetrations, openings, slots, chases, or sleeves as necessary for the routing and installation of laboratory electrical equipment. The Contractor shall provide approved fire sealant to maintain fire ratings at all penetrations.

D. The Contractor shall coordinate and cooperate with all other trades for a successful completion of the laboratory electrical work.

E. The Contractor shall install access panels in walls or ceilings in coordination with the Architect for all laboratory electrical equipment, which require access.

F. All laboratory electrical equipment shall be installed plumb, parallel, or orthogonal to structure and in a neat orderly fashion. All material shall be accessible for maintenance, inspection, servicing or replacement.

G. Verify final locations for laboratory electrical devices and equipment during the rough-in phase with dimensioned architectural drawings, fabrication drawings, or other space planning requirements included in the contract documents.

H. The Contractor shall provide adequate and qualified supervision for the work performed; no work shall be performed without the supervision of a representative of the Contractor.

3.2 GROUNDING AND BONDING

A. Special Cabinets
   1. At all flammable materials storage cabinets, solvent storage cabinets, corrosive storage cabinets and gas safety cabinets, provide a (minimum) #12 AWG copper, insulated green grounding conductor from the equipment grounding conductor of the nearest available 120 volt circuit outlet box.
   2. Extend cabinet bonding conductor from the nearest circuit outlet box via ½" conduit concealed in wall and stubbed out behind the respective cabinet. Conduit shall be converted to flexible metal conduit where exposed, and shall terminate with a UL listed bushing. Where indicated on the drawings, provide a flush wall box with cover plate (with grommeted hole, ½" diameter) and extend bonding conductor from wall box to equipment terminal.
   3. The bonding conductor shall be secured to the bonding terminal of the cabinet. If the cabinet is not equipped with a bonding terminal, provide a UL listed screw terminal and permanently secure it to the metallic cabinet with a screw, lockwasher and bolt. Self-tapping sheet metal screws will not be accepted as the means of attachment.
   4. Refer to the Lab Furnishings (LF) specifications and drawings for cabinet specs, details, quantities and locations. Bonding shall be provided at each cabinet whether or not specifically indicated at each cabinet location.

B. Grounding Bus at Storage Rooms
   1. Where indicated on the drawings, provide copper bus bar assemblies, wall mounted on insulator bushings, secured to the building framing structures.
   2. For each area containing a ground bus bar system, provide a dedicated conduit homerun to the respective branch circuit panel serving the area. Install an insulated copper grounding conductor (green color).
   3. Provide listed fittings, nuts, bolts, connectors and miscellaneous hardware for a complete ground bus system.

3.3 COMMISSIONING

A. The Contractor shall initiate start up of all laboratory electrical equipment including operation of all devices, switches, overcurrent protection, disconnect switches, etc. to verify normal operation of all moving parts and electrical performance.

B. The Contractor shall test, adjust, align, label, clean and complete all systems prior to acceptance by the Owner's Representative.

C. The Contractor shall demonstrate that all systems operate within the manufacturer's recommended performance characteristics, the laboratory electrical construction documents, system requirements, and Owner requirements.

D. The Contractor shall test each laboratory electrical system per the manufacturer's requirements and shall perform the following system tests:

1. Inspect cables for physical damage and proper connection.
2. Torque test cable connection and tighten in accordance with termination manufacturers recommendations.
3. Infrared scan all connections under loaded conditions and provide color printed images.
4. Insulation resistance test of each cable.
5. Inspect ground system connections.
6. Voltage drop tests on the main grounding electrode of system.
7. Determine the ground resistance between the main grounding system and all major electrical equipment frames, system neutral points.
8. Check rated voltage and phase balance at all equipment, motors and selected devices at full load conditions. Measure no load voltage conditions at each location.
9. Furnish all material, equipment, instruments and labor as required to complete testing.
10. Provide all test results properly bound in a three-ring binder.

3.4 CLEANING

A. Contractor shall clean all equipment, conduit interiors, fixtures, devices, etc. of all extraneous paint, drywall mud, overspray, dust, dirt, debris, trash, grease or markings. All cleaning shall be performed by the Contractor in accordance with the appropriate manufacturer's recommendations.

3.5 RACEWAYS

A. EMT shall be run indoors concealed in drywall type construction, above suspended ceilings, or in utility chases at casework or lab benches. In unfinished indoor areas, EMT shall be run exposed no less than 8'0" above finished floor.

B. EMT shall not be installed underground or embedded in concrete.

C. Flexible conduit shall not exceed 6'0" in length.

D. Flexible conduit used for final connection to laboratory equipment shall not exceed 2'0" in length.

E. The conduit grounding system shall be continuous as recommended by the manufacturer and UL approved.

F. Liquidtight flexible conduit shall be used for final connection to machines, motors, transformers and equipment that requires vibration isolation.

G. Liquidtight flexible conduit shall be used for final connection to equipment in wet or damp locations or where exposed to grease, water, dust, dirt, pathogens, vapors, or chemicals.

3.6 WIRE AND CABLE

A. All wiring methods shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

B. Conductors shall be installed in clean raceways using nylon cord, polypropylene cord, hemp rope, or other material, which will not damage the conductors or conduit. Do not use metal fish tape. Use lubricant when necessary for pulling.

C. Conductors shall be pulled into conduit simultaneously so as to not damage conductors during pulling.

D. Conductors installed at outlets and switches shall have a minimum of 6" pigtail left in the box for future connections. All conductors not connected to devices shall be terminated with splice caps and tape.

E. Conductors shall be terminated such that no copper material is exposed. Conductors shall be trained and labeled at terminations in a neat and workmanlike manner.

F. All terminations shall be mechanically sound, featuring helical twisting of the terminating conductors prior to the application of an electrical connector. The electrical connector shall not be used for the mechanical connection of the conductors.

G. All terminations shall comply with the manufacturer's installation and torquing requirements.

H. Splices on conductors #10AWG and smaller shall be made with splice caps twisted onto the conductors. Tape all splices.

I. Splices on conductors #8AWG and larger shall be made with pressure connectors and terminal lugs. Where exposed to water, damp air, or moisture, splices shall be watertight.

J. Splices shall not be made in feeders; splices to branch circuits shall not be made within panelboards or similar enclosures.

K. When combining homeruns, the Contractor shall derate all conductors per code requirements including reducing the ampacity, using high temperature insulation where necessary. Conduit sizes shall be adjusted by the Contractor as suitable for the conductor revisions.

L. The Contractor shall provide a code-sized insulated ground conductor, in addition to the feeder conductors indicated on the drawings, where non-metallic conduit is used.

M. Conductors shall be color-coded as follows or as matches the building standard:

208Y/120V	Phase	480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

N. Where tape or labels are used for color-coding, apply material at each end of the conductor, splices, boxes, and all terminations.

3.7 BOXES

A. All box installation methods shall comply with the latest enforced edition of the National Electrical Code and the authority having jurisdiction.

B. Install all boxes plumb, square, and securely fastened to structure.

C. Boxes shall be placed such that they are readily accessible.

D. Cover or plug all unused openings in boxes where knockout blanks have been removed.

E. Install boxes such that they are flush with the finished surface of the wall or surface within which they are mounted.

F. Install all boxes at mounting heights per architectural, electrical code, and ADA requirements.

G. Boxes shall not be mounted back to back in walls.

H. Boxes in sealed environments shall be sealed with an approved sealant suitable for the application.

I. Boxes penetrating fire rated walls or surfaces shall be sealed with a Fire Marshal approved fire sealant to maintain the fire rating of the wall or surface.

J. Boxes located above inaccessible ceilings shall be made accessible by means of access doors or hatches in the ceiling.

K. Install all boxes per manufacturer's recommendations and requirements.

L. Provide for ground continuity at all boxes.

3.8 WIRING DEVICES

A. Installation methods for wiring devices shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

B. Install all devices in accordance with the manufacturer's recommendations and requirements.

C. Coordinate device mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts.

D. Install devices only in clean boxes.

E. Install all trim rings and coverplates in coordination with other trades and their installation schedules.

F. Tighten and inspect all connections prior to covering devices and reconnect or repair wiring as necessary.

G. Test all devices for voltage level, continuity, ground fault, and short circuits.

H. Install all devices plumb and square to structure and adjacent surfaces.

I. Connect and inspect all ground bonds prior to covering device.

J. Demonstrate the proper operation of all ground fault interrupting devices.

3.9 DISCONNECT SWITCHES

A. Installation methods for disconnects shall comply with the latest enforced edition of the National Electrical Code and the local authority having jurisdiction.

B. Install all disconnects in accordance with the manufacturer's recommendations and requirements.

C. Coordinate disconnect mounting height, location and type with architectural and interior drawings. Coordinate with other trades to identify conflicts with device locations and notify the Engineer of any conflicts. Mount switches 42" above finished floor unless noted otherwise.

D. Provide suitable galvanized metal strut framework where no wall or structure is available for the mounting of disconnects.

E. Provide flexible conduit connections for disconnects mounted to strut framework, motors, or vibrating equipment.

F. Tighten and inspect all connections and reconnect or repair wiring as necessary.

G. Test all disconnects for voltage level, continuity, ground fault, and short circuits. Check switch mechanism operation under no load conditions prior to operating under load.

H. Install all disconnects plumb and square to structure and adjacent surfaces.

I. Provide and install all fuses sized per the equipment manufacturer's recommendation.

END OF SECTION

SECTION 270536
CABLE TRAY FOR COMMUNICATION SYSTEMS

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Product Data Sheets for all cable trays, all related components, and NEMA VE1.

B. Submit Cable Tray Support Details.

C. Provide Reproducible Floor Plan Shop Drawings, with the same scale as the Contract Floor Plan Drawings. The Drawings shall show the proposed Cable Tray Layout Plan views. An elevation view shall be provided at each riser or change in horizontal elevation in the cable tray. The Shop Drawing Plans shall show all building elements, expansion/seismic joints, air ducts, piping and components that cross the path of the cable tray, along with separation of the cable tray from the crossing components.

PART 2 PRODUCTS

2.1 CABLE TRAY

A. Material and installation shall comply with NEMA - "VE1" latest edition, Cable Tray Systems', N.E.C., California Title 24 and Title 8. As manufactured by Globe Tray, Chalfant, P-W Industries or equal.

B. Cable tray shall include two longitudinal side rails, ladder type, with transverse 6 inches rung spacing welded to side rails. Rungs shall have a minimum cable-bearing surface of 0.75-inches. Rungs shall not extend below bottom of side rails. Splice plates shall be locking bolt type to connect tray sections together without decreased tray strength. Provide expansion/ deflection fitting at each building seismic and expansion joint crossing.

C. Trays shall be steel or aluminum. Steel trays shall be hot dip galvanized after fabrication ASTM A 123 with ANSI type 304 and 316 stainless steel hardware. Aluminum trays shall be extruded from 6063-T6-aluminum alloy with 5052-H32-aluminum alloy hardware.

D. The complete cable tray system and supports shall be designed for the following minimum uniformly distributed working load but not less than indicated on the Drawings, with a 1.5 minimum safety factor, when supported as a single span. In addition, the cable tray shall support 200 pounds concentrated at span midpoint without permanent distortion.

1. Cable tray wider than 12-inches or deeper than 6 inches, live loading 200 pounds per linear foot.
2. Cable tray 12-inches or less in width and 6 inches or less in depth live loading 100 pounds per linear foot.

E. Provide ladder type "elbows", "tees", horizontal "crosses", expansion connectors, reducer sections, connectors, straight sections, curved sections, fittings, supports, hangers, blind ends, risers and accessories to provide a complete installation of the cable tray shown on the Drawings. Provide

trapeze brackets and individual threaded hanger suspension rods in any combination required to support the cable tray system. Provide all materials and labor necessary for a complete installation.

F. Cable tray runs shall be minimum 6-inches deep by 12-inches wide, but not less than indicated on Drawings. Dimensions are outside dimensions of the cable tray rails.

G. Similar cable tray parts and hardware shall be interchangeable with each other. The cable tray system shall be free of sharp edges, burrs or projections that can damage cable insulation.

PART 3 EXECUTION

3.1 CABLE TRAY

A. Cable trays shall be seismically anchored and supported to the building structure to prevent horizontal or lateral movement with 1.0-gravity acceleration, including specified live load conductor capacity, complying with State of California Seismic Codes. Support hangers from the building structure shall provide a 2.0 weight carrying safety factory including specified live cable weight. Cable tray hangers shall be provided with a spacing to insure the maximum cable tray deflection with the specified live cable loading does not exceed 0.75-inches between supports and hangers. In no case shall cable tray support or hanger spacing be greater than 12-feet on center.

B. Punching or drilling of structural side members shall not be performed except for splice plate bolt-holes.

C. Provide expansion adapters where cable trays cross a building expansion joint, and to comply with Tray Manufacturer's recommendation for the cable tray thermal expansion requirements.

D. All cable trays including non-connected tray sections shall be made electrically continuous. Provide grounding jumpers minimum equivalent to #8AWG, where required to provide continuity.

E. Grounding for cable trays shall comply with Article 318-6 of NEC.

F. Provide curved "radius" cable trays at each "horizontal" or "vertical" change in direction of the cable tray. Provide "tee" and "crosses" at each intersection of cable trays. Provide "blind ends" at the end of each cable tray "run".

G. Provide removable fire blocking "bag style" at cable tray penetrations of fire barriers.

END OF SECTION 270536
070317/1010006

SECTION 270800
COMMISSIONING OF COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all Sections of Division 27.

B. This Project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 019100 General Commissioning Requirements. The Commissioning process, which the Contractor is responsible to execute, is defined in Section 019100 General Commissioning Requirements. A Commissioning Agent (CxA) appointed by the VA will manage the Commissioning process.

1.2 RELATED WORK

A. Section 010001 General Requirements (Major NCA Projects)

B. Section 010002 General Requirements (Minor NCA Projects).

C. Section 019100 General Commissioning Requirements.

D. Section 013323 Shop Drawings, Product Data, and Samples.

1.3 SUMMARY

A. This Section includes requirements for Commissioning the Facility Communications Systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 019100 General Commissioning Requirements.

B. Refer to Section 019100 General Commissioning Requirements for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 019100 General Commissioning Requirements for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in Division 27 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance Personnel in accordance with the requirements of Section 019100 and of Division 27, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility Exterior Closure Systems Commissioning will include the systems listed in Section 019100 General Commissioning Requirements:

1.6 SUBMITTALS

A. The Commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 013323 Shop Drawings, Product Data, and Samples for further details.

B. The Commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the Commissioning process are specified in Section 019100 General Commissioning Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 CONSTRUCTION INSPECTIONS

A. Commissioning of Communications systems will require inspection of individual elements of the communications system construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 019100 and the Commissioning Plan to schedule communications systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 019100 General Commissioning Requirements for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other Commissioning Documents.

3.3 CONTRACTORS TESTS

A. Contractor tests as required by other Sections of Division 27 shall be scheduled and documented in accordance with Section 010000 General Requirements. All testing shall be incorporated into the Project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady State conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 019100 General Commissioning Requirements, for additional details.

3.5 TRAINING OF VA PERSONNEL

A. Training of the VA Operation and Maintenance Personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, Factory Authorized Personnel to provide instruction to Operation and Maintenance Personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit Training Agendas and Trainer resumes in accordance with the requirements of Section 019100. The instruction shall be scheduled in coordination with the VA Resident Engineer after submission and approval of formal Training Plans. Refer to Section 019100 General Commissioning Requirements and Division 27 Sections for additional Contractor training requirements.

END OF SECTION 270800

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SECTION 272000
ELECTRONIC NETWORK SYSTEMS INFRASTRUCTURE

PART 1 GENERAL

1.1 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 Specifications Sections and Drawings for related work required to be included as work under Division 26.
2. General provisions and requirements for electrical work.

B. Provide Electronic Network Systems Infrastructure for the following systems:

1. Computer Data Networks
2. Telephone and Intercom Voice Communications
3. Other special systems described in the Contract Documents.

C. Provide prefunctional start up and functional testing of system per 019113 General Commissioning Requirements.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Drawings Submittals

1. Drawings shall be submitted on reproducible sepias and Autocad® Version 2.2 (or later revision) data files on CD/DVD-ROM disk, WINDOWS®-XP or Version-7 or Version-8 format.
2. Submit redrawn Building Floor Plan for each building area, same scale as the Contract Drawing.
3. Plans shall show walls, doors, windows, furniture, infrastructure, outlets and network systems equipment locations. Show point-to-point interconnecting cables, pathways, conduit, conduit sizes, circuit types, along with circuit identification names, numbers and quantities between all components.
4. Provide scaled Elevation Drawings of each equipment rack, terminal blocks, terminal backboard and terminal room/closet showing location and arrangement of each equipment component, outlet and cable training provisions, with estimated weight of each complete assembly.
5. Submit block wiring diagrams showing major system components, outlets, equipment racks, terminal blocks, signal loss with interconnecting circuit conductors, splices, portable patch cords and connectors. Riser type diagram shall be provided if the building has more than one floor level, with information shown on riser diagram corresponding for each respective floor.

B. Submit Manufacturer's standard catalog data for each component. The submittal shall be arranged in the order of the Specification and shall list the Specification paragraph number, the name, the proposed model and Manufacturer for each item as well as a reference indicating the specific piece of data which can be easily located in the brochure. The Manufacturer's data sheets shall be marked to indicate the specific item being proposed in cases where the sheet covers several types or sizes of items. The data sheet shall completely describe the proposed item. Where modification to the equipment is necessary to meet the operational requirements of the Contract Documents, the brochure shall include complete Mechanical and Electrical Shop Drawings, detailing the modification. The brochure shall include a listing of the outlet rough-in requirements for every device and equipment item. The applicable symbol which illustrates that rough-in item on the Job Plans shall be drawn on the proposal, opposite the description of the rough-in to facilitate locating the data by Field Personnel. Submit elevation and dimensional information.

C. Performance Calculation:
   1. Provide engineered calculations showing the Passive Cable System Signal Attenuation losses of the proposed installed system. The intent is not to require calculations for every system segment, port and outlet. The intent is to require engineered calculations for proposed typical worst case port to port; head end to farthest distance outlet and patch port to outlet signal attenuations.
   2. Provide calculations for a minimum of 50 complete channel/circuit paths. The calculations shall include attenuation insertion losses for each system component including individually itemized cable-fiber/wire; outlet, termination, connector, electronic component (if any), coupler and patch cord along the entire path from the head end equipment to the end use outlet.
   3. The calculations shall serve as the basis for verifying the system performance with the system testing specified in the Contract Documents.

D. Provide proposed nameplate and outlet identification/color coding system. Indicate proposed identification naming sequence and methods, itemized for review.

E. Submit Manufacturer Certified Test Reports showing test documentation for the proposed material that the material meets or exceeds the performance Standards defined in the Contract Documents. The testing and results shall reflect worst case performance based on a minimum of ten samples. Tests shall be certified by a Nationally Recognized Independent Test Lab (i.e., ETL, UL, etc.). The Manufacturer shall certify in writing the material has been manufactured and tested to comply with the requirements defined in the Contract Documents.

F. Submit three samples of each of the following, fully assembled with 24-inches of cable type connected:
   1. Copper wire outlet and connector, with each type of specified inserts.
   2. Copper cables and patch cords, each type.
   3. Fiber optic cables and patch cord each type.
   4. Mechanical splice - fiber optic.
   5. Fusion splice - fiber optic.
   6. Fiber optic outlet and connector each type.
   7. Fiber optic cable connector each type of termination, with interconnection coupler.
   8. Patch panel each type.
   9. Coverplate each type.

1.3 APPLICABLE STANDARDS

A. Individual component Production/Manufacturer Testing and Labeling.
   1. The equipment shall be UL listed, labeled, and approved for the application shown in the Contract Documents.
   2. ETL (USA) each network systems infrastructure component. Third party testing, documentation and certification for performance compliance of each component with the UL, ANSI, TIA and EIA Applicable Standards specified in the Contract Documents.

B. The complete system material, equipment, testing, installation, workmanship and installed performance shall comply with the mandatory requirements and the guideline/recommendation requirements of the following latest published version, supplements, latest revision including Addendums and TSB. Both the mandatory and advisory criteria shall be included as requirements of the Contract Documents:
   1. TIA-526 Optical Power and loss measurements – multimode and single mode fiber.
   2. ANSI/TIA/EIA-568C Commercial Building Telecommunications Standards.
   3. ANSI/TIA/EIA-569B – Commercial Building Standards for Telecommunications Pathways.
   4. ANSI/TIA/EIA-570A Residential Telecommunications Standard.
   5. ANSI/TIA/EIA-598B Optical Fiber Cabling Color-Coding.
   6. ANSI/TIA/EIA-606A Administrative Standard for Commercial Telecommunications Infrastructure.
   7. ANSI/TIA/EJA-607 Commercial Buildings Grounding and Bonding Requirements for Telecommunications.
   8. FCC – FYU/FT6.

9. ISO/IEC 11801
10. National Electrical Code (NEC) and California Electrical Code (CEC) including Articles 770 and 800 with ETL verified testing and local code jurisdictions.
11. NECA/NEIS, National Electrical Contractors Association, National Electrical Installation Standards:
    a. 301 – Standard for Installation and Testing for Fiber Optic.
    b. 568 – Standard for Installing Building Telecommunications Bonding and Grounding.
    c. 607 – Telecommunications
12. Manufacturer's recommendations for the respective equipment.

C. Network Performance
1. The entire completed Electronic Network Systems Infrastructure shall be tested and provide electronic data/network and telephone/voice multi-channel communications latest revisions, Standards and Addendums for the following protocols:
    a. IEEE 802.3/ETHERNET latest revisions.
2. Twisted pairs copper wire (100 meter path length unless indicated otherwise)
    a. 10Mbps 10Base-T, 100Mbps 100Base-Tx;
    b. 1000Mbps (1Gbps) 1000 Base-Tx;
    c. 10,000 Mbps (10Gbps) 10Gb Base-Tx.
    d. IEEE-802.3 for Power Over Ethernet (POE) and Power Over Ethernet-Plus (POE Plus).
3. Fiber optic, 550 meter communications pathway distance, OM4 Standard multimode and OS2 single-mode.
    a. 10Mbps 10Base-F1, 100Mbps 100Base-FX,
    b. 1000Mbps 1000Base-Lx-Sx
    c. 10,000 Mbps (10Gbps) for fiber optics
    d. Single Mode path length performance increase requirement to 3000 meters.
4. IEEE 802.5/TOKEN RING.
5. APPLETALK (Phone-net).
6. FDDI - Distributed data interface on fiber or copper wire, 100Mbps.
7. 100VG – Any LAN
8. TIA/EIA serial and Bi-directional RS-232 and RS-485, including Star-Hub repeaters.
9. ANSI - TPPMD 55Mbps, 155Mbps and 622Mbps Asynchronous Transfer Mode - ATM.

D. The Complete Telephone/Voice Infrastructure System shall be suitable for the telephone/voice analog and digital communications and VoIP protocols. The system shall be compatible with the telephone/voice equipment installed as part of the Contract.

E. Installation of All Infrastructure Equipment, Devices, Splices, Terminations, Cables, Outlets, etc. shall comply with Manufacturer's recommendations.

1.4 EQUIPMENT QUALIFICATIONS

A. Equipment
1. The Supplier of the equipment shall be the Factory Authorized Distributor and service facility for the brands of equipment and material provided.
2. Network systems infrastructure equipment and materials shall all be the product of one of the individual same Manufacturers as follows. Typical unless specifically described otherwise:
   Belden – 10GX Series; or CommScope-Systimax X10D Series;
   or AMP/Tyco – NetConnect Series;
   or Ortronics/Legrand – NetClear Series;
   or Siemon – ConvergeIT Series.

B. Installation Certification
1. Work and material for cables, cable terminations, outlets and related components for infrastructure systems shall be performed by Certified Installers. The Installer shall be certified by the respective Product Manufacturers.
2. The Manufacturers of the indicated work and material shall provide an Installer education/ training and certification program for the supplied products.

3. The Installers performing the Contract Work for the indicated products shall have attended and successfully completed each of the respective Manufacturer's installation training education programs for the specified products.
4. Submit six copies of the Manufacturer's Certifications for each Installer performing the work. The submittal shall be approved by the Owner'S Representative prior to initiating any related Contract Work.
5. Contract material installed and work performed by Installers not complying with these requirements shall be removed. Removal of work and material not in compliance with these requirements shall done at the Contractor's expense, without any additional cost to the Contract and without any additional Contract completion due date extensions. New material and work required to replace the non-complying removed work and material shall be provided at the Contractor's expense, without any additional cost to the Contract and without any additional Contract completion due date extensions.

C. Extended Material and Performance Warranties

1. In addition to the warranty requirements described elsewhere in the Contract Documents, provide the following extended material and performance warranties. The warranty period shall be for not less than 15-years from the Contract Notice of Completion.
2. Warranty scope includes materials and performance for network cables and terminations, network workstation plug-in outlets, and patch panel plug-in outlets, cable splices and connectors.
3. Repair or replace the defective material with new material at the Project premise, to comply with the performance Standards outlined in the Contract Documents during the warranty period.
4. Submit seven copies of proposed warranty statements, with Shop Drawing submittals.

1.5 ABBREVIATIONS

Abbreviation	Terminology
ACR	Attenuation to Cross Talk.
AHJ	Authority Having Jurisdiction.
Backbone	Circuit interconnections between MDF and IDF patch panel locations.
dB	Decibel.
dBm	Decibel referenced to a milli-watt.
Demarc	Demarcation location where operational control change occurs or ownership change occurs.
ft.	Feet.
GHz	Gigahertz.
Gbps	Gigabits per second.
Horizontal Connection, and/or Horizontal wiring	Circuit interconnections between individual workstation outlet location to respective IDF or MDF equipment rack patch panel.
IDF	Intermediate Distribution Frame (horizontal or vertical cross connect) for an individual building area/floor.
km	Kilometer-lkm.
kPSI	1000 pounds per square inch.
m	Meter = 39.37 inches.
Mbps	Megabits per second.
MDF	Main Distribution Frame (central/main cross connect) for multi-building site or for a single individual building.
MHz	Megahertz.
MIC	Micrometer
mm	Millimeter = $l0^{-3}$ meter.
NEXT	Near end cross talk.
nm	Nanometer = 10^{-9} meter.
pF	Picofarad = 10^{-12} farad.
Provide	Furnish, install and connect.

RTDE	Equipment rack mount fiber optic termination distribution enclosure, with fiber optic patch panel.
RMSE	Equipment rack mount fiber optic enclosure, splice only (without patch panel).
STP	Shielded individual twisted pairs copper wire.
ScTP	Shield Screened Twisted Pairs copper wire.
Trunking-Cable	Individually insulated twisted pair copper wire cable, consisting of 24-pair or more of conductors inside a common cable jacket. Terminate and connect to common terminal-block location at each end of the trunking-cable.
um	Micrometer = 10^{-6} meter.
USE	Universal Splice Enclosure.
UTP	Unshielded twisted pairs copper wire.
VOIP	Voice communications Over Internet Protocol.
WGNA	Wide Band Gigabit Networking Alliance.
Workstation or Workstation location	Spaces remote from the MDF/IDF terminal room/closet, where user equipment interacts and connects with the electronic systems infrastructure equipment connection outlet device.
WMIC	Wall Mount fiber optic cable Interface Cabinet.

1.6 MATERIALS AND METHODS

A. Material and Labor not complying with the Contract Documents shall be removed by the Contractor from the Project Site. Material and labor complying the Contract Documents shall be provided.

B. All the cost to remove deficient work and material, provide work and material complying with the Contract Documents and 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.

C. System Performance Requirements
   1. The work, performance and type of materials provided as part of the Contract shall comply with the following ANSI/TIA/EIA-568C and related standards for all Electronics Network Systems Infrastructure work and materials described in the Specifications and shown the Drawings:
      a. Computer/data network systems: Category-6A
      b. Telephone/intercom voice systems: Category-6A
      c. Broadband transmission radio frequency for television, digital or analog cable television, digital satellite system, broadcast quality Coaxial-RG6 (QUAD SHIELDING).
      d. Trunking-cable, analog circuits copper wire twisted pairs: Category-5E.
   2. The Electronic Network Systems Infrastructure system shall be based on “star-topology”; for MDF to IDF backbone connections and workstation outlet to MDF/IDF horizontal connections.

PART 2 PRODUCTS

2.1 FIBER OPTICS CABLES

A. General
   1. Operating temperature range - 20 degrees centigrade through +60 degrees centigrade. Cables shall be flame retarding.
   2. Electronic network systems infrastructure cables that are not installed inside conduit raceways. Electronic network systems infrastructure cables that are installed in concealed spaces including plenums and non-plenums; access floors, ceiling spaces, walls, floor, etc., and/or installed without continuous raceways. The cable insulation and jacket shall be listed and labeled “Limited Combustible Cable” (LC or LCC) and shall comply with the latest published revision of all of the following additional requirements.
      a. Limited combustible “FHC-25/50” per UL-2424.

b. NEC/CEC;CMP, additional listing/labeling where the install location is an environmental air plenum, fiber optic “FHC-25/50-CMP and/or OFNP/OFCP”.
c. NFPA-90A; ceiling cavity plenums, wall cavity spaces and raised floor cavity plenums, limited-combustible.
d. NFPA-5000; defines combustible material including wire and cable.
e. NFPA-75 computer rooms and electronic equipment room.
f. NFPA-13; spaces containing “limited combustible loading”.

3. Cables shall qualify as 100% recyclable materials disposal, RoHS regulation complaint.
4. All fibers in a multi-fiber cable shall be fully operational within the performance characteristics specified prior to and after the cable is installed. The use of spare fibers in the cable to compensate for defective fibers is not permitted. Defective cables shall be removed and replaced with fully functional cables at no additional cost to the Contract.
5. Cables shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with specified requirements. ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
6. Each fiber shall be individually identified with factory color-coding or factory imprinted label. The outer cable jacket shall be imprinted with date, Manufacturer's model and catalog number, along with Agency listing identification.
7. Fiber optic cable shall be a product of the same Manufacturer, including portable patch cables.
8. Cables installed in raceways or conduits below grade, through in-grade manholes or pullboxes shall be rated for installation in water/wet locations.
9. Provide overall outer jacket enclosing all fibers inside jacket. Cables containing less than seven fiber strands shall be provided with a color coded outer jacket (red or orange).
10. Multimode (62.5/125)
    a. Fiber optic cables optical fibers, (62.5/125) graded index multimode optical glass fibers, 62.5 micron fiber core and 125 micron fiber cladding, 0.275 numerical aperture. Optical fibers shall be 100 kpsi proof tested, with maximum 0.7 micron flaw size for dual operation at 850nm and 1300nm wave lengths.
    b. Minimum bandwidth:
       @ 850nm - wave length 160MHz per km length
       @ 1300nm - wave length 500MHz per km length
    c. Maximum attenuation:
       @ 850nm-wave length 3.4 dB @ 1km length
       @ 1300nm-wave length 1.0 dB @ 1km length
    d. Laser-optimized "OM2" optical multi-mode standards.
11. Multimode (50/125)
    a. 50/125 fiber optic cables optical fibers, graded index multimode optical glass fibers, 50.0-micron fiber core and 125-micron fiber cladding, 0.2 numerical aperture. Optical fibers shall be 100 kPSI proof tested, with maximum 0.7 micron flaw size for dual operation at 850nm and 1300nm wave lengths.
    b. Minimum bandwidth:
       @ 850nm-wave length 3500Mhz per km length
       @ 1300nm-wave length 500Mhz per km length
    c. Maximum attenuation:
       @ 850nm-wave length 3.0db @ 1km length
       @ 1300nm-wave length 1.0db @ 1km length
    d. Laser-optimized "OM4" optical multi-mode standards.
12. Single mode:
    a. Fiber optic cables optical fibers, (8.3/125) single mode optical glass fibers, 8.3-micron core fiber and 125-micron fiber cladding, 0.11 numerical aperture. Optical fibers shall be 100-kPSI proof tested, with maximum 0.7-micron flaw size. For operation at 1310nm and 1550nm wave lengths.
    b. Maximum attenuation:
       @ 1310nm- wave length 0.5 dB @ 1km length
       @ 1550nm- wave length 0.4 dB @ 1km length
    c. Maximum dispersion
       @ 1310nm- wave length 2.8 ps/nm km length
       @ 1550nm- wave length 18.0 ps/nm km length
    d. Laser-optimized "OS1"/OS2" optical single mode standards.

B. Loose Tube Gel-filled Cables

1. Multiple, loose tube buffer tubes, gel-filled. Each buffer tube shall contain the same quantity of optical fibers, but not more than twelve optical fibers in each buffer tube.
2. Buffer tubes shall be cabled around a central dielectric strength member. The central strength member shall be centered along the length of the cable.
3. Aramid yarn, non-optical, strength fibers shall extend continuously along the length of the cable.
4. The cable interstitial spaces shall be flooded to inhibit water migration, with non-flammable water blocking gel.
5. Each optical fiber shall be individually UV cured acrylate coated, 250-micron diameter coating over fiber cladding.
6. A seamless black polyethylene outer layer jacket shall envelope the entire cable.
7. The cable shall be fungus resistant, UV resistant, and moisture resistant for installation indoors with or without an enclosed raceway and outdoors in underground enclosed raceway/conduit and manholes/pullboxes continuously flooded with water.

C. Indoor/Outdoor Cables

1. The cable shall be fungus resistant, UV resistant, moisture resistant for installation indoors with or without an enclosed raceway and outdoors in underground enclosed raceway/conduit and manholes/pullboxes continuously flooded with water, and in conduits exposed to the sun.
2. Each optical fiber shall be primary coated with 500 micron uniform acrylate tight buffered and with elastomeric uniform 900-micron diameter tight buffered, secondary coating. Aramid yarn strength member elements shall be tensioned and symmetrically and uniformly distributed around the fibers, along the length of the cable.
3. An overall cable jacket uniformly extruded directly around and mechanically interlocked with the optical fibers/strength members. The extruded jacket shall form internal helical cusped ridges that interlock with the optical fibers and strength members. The interlocking jacket shall not allow cable fibers to move axially within the cable jacket.
4. Cables containing more than twenty-four optical fibers shall be constructed with sub-cable fiber bundles. Each sub-cable bundle shall contain equal quantities of optical fibers, with a separate PVC jacket around each sub-cable. Sub-cable and sub-cable jacket construction shall match the overall cable requirements and jacket requirements.
5. The cable shall be UL listed and comply with NEC and NFPA requirements for each installation location shown in the Contract Documents. ETL tested and certified to comply with or exceed specified requirements.
    a. NEC – OFNR (Vertical Riser Type Locations) OFNP (UL FHC-25/50 LC Plenum Type Locations and locations where not continuously enclosed inside conduits for entire cable length).
    b. NEC – OFNG (Where continuously enclosed inside conduits for entire cable length).

D. Tight Buffered Cables

1. Each optical fiber shall be coated, 900-micron diameter uniform coating, with uniform tight buffering over the coating, uniform dielectric strength member surrounding the buffering coating and an overall jacket around each optical fiber assembly.
2. Individual multiple optical fiber assemblies shall be symmetrically arranged around a central dielectric strength member. The central strength member shall be centered along the length of the cable.
3. A dielectric strength member shall surround the fiber assemblies.
4. An outer dielectric jacket shall envelope the entire cable.
5. The cable shall be UL listed and comply with NEC and NFPA requirements for each installation location shown in the Contract Documents. ETL tested and certified to comply with or exceed specified requirements.
    a. NEC - OFNP (UL FHC-25/50 LC Plenum type locations and locations where not continuously enclosed inside conduits for entire cable length).

2.2 COPPER WIRE CABLES (TWISTED PAIRS)

A. General

1. Conductors shall be copper wire, individually insulated and color coded, with multiple conductors arrange in twisted pairs.
2. An overall non-conductive jacket shall encase the copper wires and any shielding (where shielding is specified) shall also be encased by the jacket.
3. Cables shall be UL listed, complying with NEC National Electrical Code, National Fire Protection Agency and NFPA requirements for each installation location shown. ETL tested and certified to comply with or exceed specified requirements.
   a. NEC – MPP/CMP, FHC-25/50 (Plenum type locations and locations where not continuously enclosed inside conduit).
   b. NEC – MPR/CMR (Vertical riser type locations).
   c. ANSI/TIA/EIA-568C; including related standards, amendments and TSB.
4. Electronic network systems infrastructure cables that are not installed inside conduit raceways. Electronic network systems infrastructure cables that are installed in concealed spaces including plenums and non-plenums; access floors, ceiling spaces, walls, floor, etc., and/or installed without continuous raceways. The cable insulation and jacket shall be listed and labeled “Limited Combustible Cable” (LC or LCC) and shall comply with the latest published revision of all of the following additional requirements.
   a. Limited combustible “FHC-25/50” per UL-2424.
   b. NEC/CEC;CMP, additional listing/labeling where the install location is an environmental air plenum, copper wire “FHC-25/50-CMP”.
   c. NFPA-90A; ceiling cavity plenums, wall cavity spaces and raised floor cavity plenums, limited-combustible.
   d. NFPA-5000; defines combustible material including wire and cable.
   e. NFPA-75 computer rooms and electronic equipment room.
   f. NFPA-13; spaces containing “limited combustible loading”.
5. Cables shall qualify as 100% recyclable materials disposal, RoHS regulations complaint.
6. Cables installed in air plenums, air-handling spaces and cables installed without raceway or conduit shall also be UL listed and labeled for installation in air plenums.
7. Cables installed in raceways or in conduits below grade, or through in-grade manholes and pullboxes, shall be rated for installation in water/wet locations.
8. The outer cable jacket shall be imprinted with date, Manufacturer’s model and catalog number and Agency (AHJ) listing identification.
9. Copper wire Electronic Network Systems Infrastructure cable shall be a product of the same Manufacturer, including portable patch cables.
10. The outer jacket of cables with less than nine pair of conductors shall be color-coded. The jacket color shall be different for each system type; multimedia; telephone/voice; computer/data network; and fiber cable jackets.
11. 300-volt RMS insulation material for each data conductor shall be the same material; shall be the same electrical characteristics and shall be the same dielectric constant, for all data conductors contained within the respective common cable jacket, along the entire installed length of the cable. Data cables employing differing insulation materials for individual data conductors contained within a common cable jacket are not acceptable and shall not be provided.
12. Propagation and “Skew” Rate
    a. Skew rate (nominal velocity of propagation delay) between any twisted pair in a combination of four twisted pair conductors grouped in the same cable, shall not exceed 35-nano seconds between any wire pair contained in the conductor group, and as required by the cable Category rating, over a cable length of 328-feet (100 meters), for all frequencies up to the cable maximum frequency rating.
    b. Nominal velocity of propagation, exceeding 70% of the speed of light.
13. Large capacity feeder cables and trunking-cables
    a. Copper wire cables with more than twenty-four twisted pairs of conductors shall be constructed with twenty-five pair binder groups of conductors. The cable binder groups shall be enclosed in colored binders and assembled to form a single cable. The twisted pair/binder groups shall be enclosed with multi-layer dielectric protective sheaths

underneath a cable jacket enclosing the entire cable assembly. A corrugated metal 100% shield shall be provided under the cable jacket enclosing all conductors.

b. Cables shall be wet location rated and listed for installation in conduit, where the conduit is in a wet environment and/or high-temperature environment, including:
   - Underground conduit.
   - Inside manholes and pull boxes.
   - Outdoor conduit exposed to weather and/or sunlight.

c. ANSI/TIA/EIA Category rating of cable assembly shall be Category-5E, trunking-cable.

B. Trunking Cables - Category-5E Computer/Data Enhanced Cables – UTP

1. Category-5E cables shall be tested and shall pass ANSI/TIA/EIA test recommendations for Category-5E.
2. Operational characteristics:

a.	Wire size	24AWG solid copper (24AWG stranded copper for portable patch cables)
b.	Quantity of twisted pairs	As indicated but in no case less than 4- twisted pairs
c.	Impedance	100 OHM ± 15%, 3-100MHz
d.	Maximum Signal Attenuation Per 300 feet (100 meters)	6.3dB @ 1MHz 13dB @ 4MHz 18dB @ 8MHz 20dB @ 10MHz 25dB @ 16MHz 28dB @ 20MHz 32dB @ 25MHz 36dB @ 31.25MHz 52dB @ 62.5MHz 67dB @ 100MHz
e.	Mutual Maximum Capacitance of Any Pair	14pf/feet
f.	Worst Pair "NEXT" Loss Per/328-feet (100 meters)	62dB @ 1Mhz 53dB @ 4Mhz 48dB @ 8Mhz 47dB @ 10Mhz 44dB @ 16Mhz 42dB @ 20Mhz 41dB @ 25Mhz 40dB @ 31.25Mhz 35dB @ 62.5Mhz 32dB @ 100Mhz

3. ScTP, all the wires in the cable shall be enclosed in a common, 100% metallic foil shield with copper "drain" wire, shield and drain wire located under the cable jacket.

C. Network Cables - Category-6 Computer/Data Enhanced Cables –UTP

1. Category-6 cables shall be tested and shall pass the ANSI/TIA/EIA test recommendations for Category-6.
2. Operation Characteristics:

a.	Wire size	23AWG solid copper (23AWG stranded copper for portable patch cables)
b.	Quantity of twisted pairs	As indicated but in no case less than 4-twisted pairs
c.	Impedance	100 OHM ± 15%, 1-500Mhz
d.	Maximum Signal Attenuation Per 328-feet (100 meters)	2.1dB @ 1Mhz 3.8dB @ 4Mhz 5.9dB @ 10Mhz 7.5dB @ 16Mhz 8.4dB @ 20Mhz 10.5dB @ 31.25Mhz 15.0dB @ 62.5Mhz 19.1dB @ 100Mhz 27.6dB @ 200Mhz

31.1dB @ 250Mhz
34.3dB @ 300Mhz
40.1dB @ 400Mhz
45.3dB @ 500Mhz

e. Mutual Maximum Capacitance of Any Pair 4.4nF/100m
f. Worst Pair "NEXT" Loss Per/328-feet (100 meters)

67.0dB @ 1Mhz
67.0dB @ 4Mhz
67.0dB @ 10Mhz
67.0dB @ 16Mhz
67.0dB @ 20Mhz
67.0dB @ 31.25Mhz
65.6dB @ 62.5Mhz
42.3dB @ 100Mhz
58.0dB @ 200Mhz
56.5dB @ 250Mhz
55.3dB @ 300Mhz
53.5dB @ 400Mhz
52.0dB @ 500Mhz

3. ScTP, all the wires in the cable shall be enclosed in a common, 100% metallic foil shield with copper "drain" wire, shield and drain wire located under the cable jacket.

2.3 COPPER WIRE CABLES (COAXIAL)

A. General
1. An overall non-conductive jacket shall encase the copper wires and shielding.
2. Cables shall be UL listed, complying with NEC National Electrical Code, National Fire Protection Agency and NFPA requirements for each installation location shown. ETL tested and certified to comply with or exceed specified requirements. In addition to the UL listing requirements for Copper wire Cables twisted pair, coaxial cable shall additionally be UL listed and labeled for each install location.
   a. NEC - CATVP (Plenum type locations and locations where not continuously enclosed inside conduit).
   b. NEC - CATVR (Vertical riser type locations).
   c. NEC - CATV (Locations where continuously enclosed inside conduit).
   d. ANSI/TIA/EIA-568C; including related Standards, Amendments and TSB.
3. Electronic network systems infrastructure cables that are not installed inside conduit raceways. Electronic network systems infrastructure cables that are installed in concealed spaces including plenums and non-plenums; access floors, ceiling spaces, walls, floor, etc., and/or installed without continuous raceways. The cable insulation and jacket shall be listed and labeled “Limited Combustible Cable” (LC or LCC) and shall comply with the latest published revision of all of the following additional requirements.
   a. Limited combustible “FHC-25/50” per UL-2424.
   b. NEC/CEC; CMP, additional listing/labeling where the install location is an environmental air plenum, “FHC-25/50-CMP”.
   c. NFPA-90A; ceiling cavity plenums, wall cavity spaces and raised floor cavity plenums, limited-combustible.
   d. NFPA-5000; defines combustible material including wire and cable.
   e. NFPA-75 computer rooms and electronic equipment room.
   f. NFPA-13; spaces containing “limited combustible loading”.
4. Cables shall qualify as 100% recyclable materials disposal, RoHS regulation complaint.
5. The outer cable jacket shall be imprinted with date, Manufacturer’s model and catalog number and agency (AHJ) listing identification.
6. Cables installed in air plenums, air-handling spaces and cables installed without raceway or conduit shall be UL listed and labeled for installation in air plenums.
7. Cables installed in raceways or conduits below grade, through in-grade manholes and pullboxes shall be rated for installation in water/wet locations.
8. Copper wire Electronic Network Systems Infrastructure cable shall be product of the same Manufacturer, including portable patch cables.

B. RG6 Coaxial Cables

1. ANSI/TIA/EIA-568C cables. RG-6, Quad-Shield cables, shall be tested and shall pass ANSI/ TIA/EIA test recommendations for the cable type. Rated for both analog and digital RF signal circuits.
2. Operational characteristics:
   a. Single center conductor size 18AWG stranded or solid bare copper.
   b. Velocity of propagation not less than 82%.
   c. Impedance 75-OHM.
   d. Maximum signal attenuation per 100-feet.
      - Baseband Video 0.26dB @ 1MHz
      - Upstream Digital Cable 0.76dB @ 10MHz
      - TV ch. 2 1.46dB @ 50MHz
      - FM Radio 2.05dB @ 100MHz
      - TV Ch. 12 2.83dB @ 200MHz
      - CATV Ch. 54 4.05dB @ 400MHz
      - CATV Ch. 109 5.60dB @ 700MHz
      - CATV Ch. 142 6.23dB @ 900MHz
      - DBS 6.59dB @ 1000MHz
      - DBS 7.50dB @ 1200MHz
      - DBS 8.04dB @ 1450MHz
      - PCS Cell Phones 8.50dB @ 1800MHz
      - Wireless Cable 9.00dB @ 2200MHz
      - High Frequency 13.7dB @ 3000-4500MHz
   e. Capacitance 16.2 pf/feet
   f. ASTM-D4566, 5 thru 4500MHz Return Loss Headroom (RLH) not less than 20dB.
   g. 100% sweep tested 5MHz thru 4500MHz
3. Four alternating layers of metal foil shielding and brass braiding shielding, 100% metallic shielding below the jacket and symmetrically enclosing the individual layers of dielectric insulation surrounding the center conductors.

2.4 FIBER OPTIC FIBER SPLICES

A. General

1. Fiber optic cable splices shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA–568C including related Standards, Amendments and TSB.
2. Fiber optic splices shall be the product of the same Manufacturer.

B. Mechanical Splice

1. Mechanically splice each fiber with a splice suitable for use with the type of fiber optic fibers. Re-enterable and reusable splice. Splice shall be recommended as compatible with the optical fibers by the Manufacturer. Splice shall not require the use of adhesives. Splice shall provide integral strain relief.
2. Performance requirements after installation:
   a. Operating temperature range minus 20-degrees centigrade through plus 60-degrees centigrade.
   b. Loss variation over temperature range, 0.05dB or less at specified wave lengths.
   c. Insertion loss, 0.3dB or less at specified cable wave lengths.
   d. Reflection (return loss), -40dB at specified cable wavelengths.

C. Fusion Splicing

1. Fusion splicing shall be performed with equipment providing the following features:
   a. Cleaving and cleaning optical fiber.
   b. Integral splice optimization verification system with local injection and detection.
   c. Projection screen optics and fiber core alignment system.
   d. Fiber cleaning/stripping.
   e. Cleaning fiber ends and fusing of fiber together with an electric arc.
2. Fusion splice insertion loss as measured at the completion of the splice shall be less than 0.1dB at specified cable wave lengths.

2.5 FIBER OPTIC FIBER CONNECTORS AND INTERCONNECTION COUPLERS

A. General
   1. The connectors and interconnection couplers shall be compatible, maintain the same performance Category rating and be compatible with the corresponding fiber optic cable type attached to the connectors.
   2. Fiber optic cable connectors and interconnection couplers shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements. Connectors and couplers shall comply with ANSI/TIA/EIA-568C, related Standards, Amendments, TSB, and TIA/EIA-Fiber Optic Connector Intermateability Standard (FOCIS) documentation.
   3. Fiber optic connectors and couplers shall be the product of the same Manufacturer.
   4. Shall be UL listed and comply with UL94V-0.
   5. Color code connectors for fiber optic cables to match the respective fiber optic strand/jacket color.

B. Fiber Optic Fiber Connectors
   1. LC – Small Form Factor (SFF) termination connector
      a. Ceramic oxide 1.25mm ferrule. Mechanical durability not less than 500-mating cycles. Insertion loss of mated connector shall be less than 0.3dB at specified wavelengths.
      b. Strain relief boot, long boot type unless indicated otherwise, short or angled boot type to match the connector installation application. Provide duct cover cap for each connector.
      c. Locking type to automatically align mating fibers in the fiber cable and prevent accidental rotation and pullout.
   2. ST type bayonet termination connector
      a. Ceramic aluminum oxide 2.5mm ferrule, multi-cure ultra violet or heat cured epoxy bonded, for multimode or single mode to match cable fiber. Insertion loss of each mated connector shall be less than 0.3dB at specified wavelengths.
      b. Strain relief boot, long boot type unless indicated otherwise, short or angled boot type to match the connector installation application. Provide dust cover cap for each connector.
      c. Locking type, to automatically align fiber cable and prevent accidental pullout.
   3. SC – Square/Subscriber termination connector
      a. Ceramic oxide 2.5mm ferrule.
         Insertion loss of mated connectors shall be less than 0.3dB at specified wavelength.
      b. Strain relief boot, long boot type unless indicated otherwise, short or angled boot type to match connector installation application. Provide dust cover cap for each connector.
      c. Push-pull snap and lock type to automatically align mating fibers in the fiber cable and prevent accidental rotation and pullout.
   4. "FSD" fixed shroud duplex type termination connector

C. Fiber Optic Fiber Interconnection Couplers
   1. Interconnection couplers shall be “like-to-like” compatible, and shall provide "plug-in" coupling of two fiber optic cable connectors terminated with fiber optic fibers front-to-rear "in-line" together. The coupler shall provide interlocking, automatic optical self-alignment of two mating fiber optic connectors.
   2. The centerline to centerline spacing of the interconnection couplers shall allow removal and insertion of portable patch cords, fiber cable connectors for both “single” and “duplex” type fiber adapter connectors without interfering with adjacent connectors.
   3. Patch panel mounted interconnections couplers shall be factory pre-mounted to a modular nominal 0.09-inch thick metal panel, couplers aligned and anchored on the plate.
      a. The metal panel shall be predrilled for Standard EIA mounting in high-density 19-inch wide metal patch panel frames.
   4. Interconnection couplers in workstation outlets shall be installed in outlet boxes with cover plates.
   5. Provide removable dust caps for the front side of each coupler.

2.6 COPPER WIRE OUTLET CONNECTORS

A. General
   1. Connectors shall comply with FCC part-68 Subpart F for gold plating.
   2. Connectors shall be UL listed and shall comply with UL94V-0.
   3. Provide a removable blank dust cover for each plug-in outlet insert. The dust cover shall protect the insert from contamination until a workstation or patch cord is "plugged" into the outlet.
   4. Copper wire outlet connectors shall be color coded to distinguish telephone/ voice separately from computer/data. The outlet cover plate shall be engraved to identify telephone/voice, computer/data and other infrastructure outlets separately.
   5. Copper wire outlet connectors shall be UL listed, complying with National Electrical Code, ETL tested and certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
   6. Copper wire outlet connectors shall be the product of the same Manufacturer.

B. Universal Outlet Connector (for twisted pair Copper Wire Premise/Workstation Wiring and copper wire patch panels).
   1. General
      a. Connections for twisted pairs copper conductors shall provide a universal outlet connector between the building premise copper wire, and plug-in workstation locations. Patch panel/ equipment plug-in connectors. The connector components shall assemble with "snap-in" spring loaded retainers to prevent dislocation during insertion or removal of external plug-in devices.
      b. The contacts shall be gold plated with a 250 insertion/withdrawal cycle rating.
      c. Unless specifically noted otherwise the universal outlet connector shall comply with ANSI/ TIA/EIA-568C; related Standards, Amendments and TSB.
      d. Operational characteristics shall match or exceed and shall be compatible with the respective twisted pair's cable.
      e. A metal ground shield with EMI/RFI metal ground clip shall be provided where shielded cable is connected to the universal outlet connector for each universal outlet connector assembly.
      f. Each universal outlet connector shall consist of three major components.
         1) Universal edge connector assembly.
         2) Plug-in adapter inserts.
         3) Connector housing.
      g. Provide snap-in blank removable insert covers for connector installed without plug-in adapter inserts.
   2. Universal edge connector:
      a. Insulated assembly shall connect to the premise copper wire. The connectors shall be multiple plug type connector contacts, one contact (total of eight contacts) for each individual premise wire connection interconnected to the individual wire terminations.
      b. Connector shall provide insertion of individual insulated copper wire, gas tight, 110-style punch down/displacement termination, for 22-26 AWG insulated premise wire.
      c. The edge connector assembly shall provide termination of eight separate wire conductors, twisted or untwisted pairs, solid or stranded, shielded or unshielded, with color codes and numbered identification of each contact. Integral cable/conductor strain relief to prevent pullout of terminated premise wire conductors.
   3. Plug-in adapter inserts:
      a. Plug-in adapter inserts shall be internally factory connected to the universal edge connector assembly to adapt the universal connector to the specific outlet type configuration (i.e. "RJ" style computer/data, telephone/voice, (multimedia) modular jacks, etc.).
      b. Inserts shall be certified for shielded or unshielded wire, to match premise wire type connected to the universal edge connector.
      c. Inserts shall provide correct pin-to-pin connections, electrical and mechanical matching characteristics for the specific equipment connected to the respective outlet.
      d. Inserts for different infrastructures shall be color coded with different colors from each other, for system identifications.

e. Plug-in adapter insert type:
    1) Computer/data network systems:
        a) ANSI/TIA/EIA-568C, female modular jack 8-position/contact "RJ-45" style.
    2) Telephone/intercom voice systems:
        a) ANSI/TIA/EIA-568C female modular jack 8-position/contact RJ-45 6-position/ contact RJ-11 style.
    3) Multimedia audio/video tv (baseband only):
        a) ANSI/TIA/EIA-568C female modular jack 8-position/contact RJ-45 style.
        b) Each multimedia audio/video outlet location provides a Balun to match the circuit impedance of the premise wiring to the multimedia outlet signal type.
    4) Intrusion detection/access control systems:
        a) ANSI/TIA/EIA-568C female modular jack 8-position/contact RJ-45 style.
        b) Each intrusion detection system outlet location provides a Balun to match the circuit impedance of the premise wiring to the intrusion system outlet signal type.

4. Connector housing:
    a. Connector housing shall contain the universal edge connector assembly and the plug-in adapter inserts in a rigid assembly. Connector housing shall provide integral cable strain relief for the premise wiring connection.
    b. The connector housing shall mount to a metal panel, metal device cover plate or plastic device cover plate with spring loaded snap-in retainers. Nominal depth of connector housing behind the mounting panel and/or device cover plate shall not exceed 1.625-inch including premise wiring termination depth requirements.

C. Coaxial Cable Connectors
1. General
    a. BNC type connectors, for coaxial cable premise/workstation wiring and coaxial cable patch panel equipment.
    b. Unless noted otherwise, the BNC connectors shall comply with ANSI/TIA/EIA-568C and related Standards, Addendums and TSB.
    c. Brass body and male contact. Beryllium copper or bronze female contact. Bayonet coupling with threaded or cam-locking mating connection.
2. Operational characteristics shall match or exceed and shall be compatible with the respective coaxial cable. 75-OHM, operational frequency range 0-4500MHz.

2.7 FIBER OPTIC FIBER DISTRIBUTION ENCLOSURES

A. General
1. Fiber optic fiber distribution enclosures shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/ EIA–568C including related Standards, Amendments and TSB.
2. Fiber optic fiber distribution enclosures shall be the product of the same Manufacturer.

B. Equipment Rack Mount Fiber Optic Termination Distribution Enclosure - RTDE
1. The RTDE enclosure shall mount in an EIA Standard 19-inch wide enclosed or open frame equipment rack assembly. The RTDE enclosure shall be metal, painted finish, Manufacturers standard color.
2. The RTDE shall provide the following self-contained functions internal to the RTDE assembly.
    a. Fiber cable termination.
    b. Fiber cable "pig-tail" splicing.
    c. Fiber cable patch panel.
    d. Fiber cable management, training and strain relief.
    e. Individual fiber and patching port identification numbers, color-coding of incoming trunk and out-going distribution fiber ports.
    f. Plug-in fiber optic interconnection couplers for port to port patching with portable fiber optic patch cords.
3. Fiber splice drawers:
    a. Horizontal sliding metal drawers adjustable to approximately 30-degree angle when fully open, and removable for easy access. Each drawer shall contain two fiber optic splice trays with tray holders.

b. Drawers shall stack vertically one above the other in the RTDE and allow sufficient slack in all fiber cables for removal of the drawer and splice trays.
c. Provide one sliding drawer and two splice tray assemblies for each group (twenty-four individual fibers or fewer fibers per group) of fiber optic fibers terminated in the equipment rack, but in no case provide not fewer than two sliding drawers with splice tray assemblies in each RTDE.

4. Fiber cable patch panel
   a. Metal panel shall provide a patch port for each fiber consisting of metal panel mounted fiber optic interconnection couplers for each fiber optic fiber indicated to be terminated at the RTDE.
   b. The fiber optic fiber interconnection coupler shall be provided to match and be compatible with the fiber cable connectors. Quantity shall match quantity of terminated fibers, unless indicated otherwise on the equipment rack schedules.
   c. Nominal panel thickness 0.09 inches.
   d. Provide a minimum of sixteen unused spaces for additional couplers in the patch panel.
5. Nominal height of the RTDE shall not be exceeded, as follows:

Quantity of Patch Ports	Quantity of Splice Drawers	Nominal Height
24	2	11-inches
48	2	11-inches
72	3	14-inches
144	6	28-inches

C. Equipment Rack Mount Fiber Optic, Splice only (for use only where fiber patch panel is not required) enclosure - RMSE
1. The RMSE enclosure shall mount in an EIA Standard 19 inch wide enclosed or open frame rack assembly. The enclosure shall be metal, painted finish, Manufacturer's standard color.
2. The RMSE shall provide the following self-contained functions internal to the RMSE assembly:
   a. Fiber cable splicing for "thru splicing" of fiber optic cables where the cables do not terminate in the equipment rack.
   b. Fiber cable management, training and strain relief.
3. Fiber splice drawers
   a. Horizontal sliding metal drawers adjustable to approximately 30-degree angle when fully open and removable for easy access. Each drawer shall contain 2-fiber optic splice trays with splice tray holders.
   b. Drawers shall stack vertically one above the other in the RMSE and allow sufficient slack in all fiber cables for removal of the drawers and splice trays.
   c. Provide one sliding drawer and two fiber optic splice tray assemblies for each group (twenty-four individual fibers or fewer fibers per group) for fibers optic fiber routed through but not terminated in the equipment rack, but in any condition provide not fewer than two sliding drawers with splice tray assemblies in each RMSE.
4. Nominal height of the RMSE shall not be exceeded, as follows:

Quantity of Thru Splices	Quantity of Splice Drawers	Nominal Height
24	2	4-inches
48	2	4-inches
72	4	8-inches
96	4	8-inches

2.8 COPPER WIRE PATCH PANELS

A. General
1. Copper wire patch panels shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
2. Copper wire patch panels shall be the product of the same Manufacturer.

B. Equipment Rack Mounted Patch Panel

1. Standard EIA 19-inch wide metal panel, Manufacturers standard color. Prepunched for copper wire outlet connectors. Panel shall mount on an EIA standard 19 inch wide enclosed or open frame equipment rack assembly. Nominal twenty-four copper wire outlet connectors in a horizontal row, quantity of rows as required for total quantity of connectors. Provide not less than two spare empty rows for future copper wire outlet connectors.
2. The patch panel shall provide the following self-contained functions.
   a. Copper wire cable termination including conductor/shield termination and strain relief.
   b. Plug-in copper wire outlet connectors for port to port patching with copper wire portable patch cords.
3. Patch panel height shall be based on the quantity of copper wire outlet connectors described plus the specified space for future outlets and shall not exceed the following dimension height:

Outlet Quantity	Nominal Patch Panel Height
1-24	3.5 inches
25-48	7 inches
49-72	10.5 inches
73-96	14 inches

4. Horizontally mounted, cable support metal bracket shall be provided for each twenty-four (24) outlet/connector groupings. The brackets shall be bolted to the equipment rack located at the backside of the patch panel; the brackets shall support and provide strain relief for each incoming copper wire cable connecting to the patch panel.
5. The copper wire connector installed in the patch panel shall be the same configuration, Manufacturer and type as the corresponding copper wire connector provided in the remote workstation outlet locations connecting to the respective patch panel outlet, unless indicated otherwise.
6. Each multimedia, audio/video/TV multimedia and intrusion detection/access control outlet. Provide a Balun, to match the circuit impedance of the premise wiring and to the outlet signal type.

2.9 TELEPHONE/VOICE TERMINAL BLOCKS

A. General

1. Terminal blocks Type 110, shall consist of wiring blocks, connecting blocks, direct wire/patch cord cross connection and designation strips. Arrange in unitized, modular, vertical mounting sections, for telephone/voice.
2. Completely 100% front accessible for cross connections, terminating conductors, training, and fanning of cables. Rear access for any reason shall not be permitted.
3. Telephone/voice terminal blocks shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements. Telephone terminal blocks and connections performance shall comply with ANSI/TIA/ EIA-568C and related Standards, Addendums and TSB and shall comply with and be listed under UL 1863. Category rating shall match the cables connecting to the patch panel.
4. The telephone/voice terminal blocks shall provide cross connection of telephone/voice four pair premise copper wiring from telephone/voice handset outlets to multiple copper wire telephone/ voice feeder cables and external free standing telephone equipment.
5. Each full height vertical section terminal block assembly shall terminate a minimum of 900 pairs (including specified spares for future construction phases) of telephone/voice conductors, plus associated cross connection wiring and patch cords in a nominal 20-inches wide by 90-inches high space. Provide multiple vertical sections of terminal block assemblies adjacent to each other, total quantity as required for quantity of telephone/voice conductor pairs and telephone/ voice feeder cable pairs shown on the Drawings and requirements, plus specified spares.
6. Each telephone/voice terminal block vertical section assembly shall provide 15% or 100 (whichever is the larger quantity) of spare unused conductor pair terminals for future telephone/ voice connections.
7. Provide a common ground bus in each terminal block section with a minimum of six ground conductor termination positions, #10AWG through #6AWG.
8. Terminal blocks shall be the product of the same Manufacturer.

B. Wiring Blocks
   1. One piece molded, die-electric thermoplastic blocks. The wiring block shall support and secure all the components of the terminal block assembly, and provide cable/conductor training and organization.
   2. Fire retardant complying with UL 94V-0.
   3. Standoff type support legs for mounting to backboard with pre-drilled anchor holes.
   4. Non-conductive electrically quiet front assembly.
   5. Horizontal index strip rows, for termination of not less than twenty-five conductor pairs on each row. Color coded and marked in groups of four pairs or five pairs to match connecting cables.
   6. Removable retainers at the ends of each horizontal connecting block index strip row, shall support cross connect wires at corner turns.
   7. Distribution rings shall retain cross connect wire horizontal routing between terminations.
   8. A full width, horizontal trough between each 100 pair wiring block shall provide a path for patch cord training and retention.

C. Connecting Blocks
   1. Connecting blocks shall provide gas tight conductor electrical connections with conductor insulation displacement punch down slots, for insertion onto the telephone/voice wiring block index strips.
   2. Connecting blocks shall electrically connect one-to-one between each conductor terminated at the wiring block index strips, and each cross connect/patch cord conductor terminated/ connected to the opposite front side of the connecting block.
   3. Both sides of the connecting blocks shall terminate telephone/voice UTP 22-26AWG stranded or solid copper wire individually insulated conductors. The front side of the connecting blocks shall also provide "plug-in" connections for portable patch cords, 110 style "plug-in" connectors.
   4. Connection blocks shall be 4-pair insulated copper conductor type.
   5. Provide insulated, removable termination caps for each connector block.
   6. Connector blocks shall be marked to indicate tip and ring conductors and to indicate polarization.

D. Designation Strips
   1. Designation strips shall provide retention of interchangeable labels. The labels shall show circuit identification of each terminated conductor pair.
   2. The designation strips shall mount on the center and outside positions of the wiring block.

E. Telephone/Voice Cross Connection
   1. The cross circuit connection between incoming and outgoing feeder cables and telephone voice outlet wiring shall be provided in the terminal block assembly.
   2. The cross connection wiring shall terminate incoming and outgoing circuit conductors between respective connecting blocks.
      a. Direct connect cross connection shall provide internally wired one-to-one conductor twisted pair cross connection. Provide cross connection of each 4-pair telephone/voice outlet cable to corresponding 4-pairs of the telephone/voice feeder cable and cross connection of feeder to feeder cables, as applicable.
      b. Patch panel cross connect, 110 terminal connector style, plug-in. Provide [one, two, three] twisted pair, 110 connector type portable patch cords.
      c. Prewired 50 pin-Amphenol connectors:
         1) Provide factory prewired fifty pin Amphenol connectors for connection from telephone/voice terminal blocks to the telephone switch equipment and Telephone Utility Company outside telephone service lines.
         2) Provide fifty pair ANSI/TIA/EIA-568C and related Standards, Addendums and TSB cables, connected to fifty pin Amphenol connectors at one end (telephone equipment connection) and connected to the respective telephone/voice terminal wiring blocks at the other end.
         3) The 50 pin Amphenol connectors shall group together and be positioned at the top of the respective terminal block section near the ceiling.
         4) The pin-to-pin conductor assignments shall conform to the Telephone Switch Manufacturer's requirements.

5) The Amphenol connector/cable assemblies shall connect to and extend the telephone/ voice outlet premise wiring from telephone/ voice terminal block to the telephone switch equipment. The Amphenol connector/cable assembly shall connect to and extend the Telephone Utility Company outside telephone service lines to the telephone switch equipment.

d. Prewired "RJ" style modular jacks
   1) Provide factory prewired eight position/contact plug-in "RJ" style jacks for patch panel portable patch cord cross connects, located on the front side of the terminal blocks.
   2) The pin-to-pin conductor assignments shall conform to the Telephone Switch Manufacturer's requirements.

2.10 EQUIPMENT RACK

A. General

1. An equipment grounding bus, nominal 19-inches long, UL labeled as a ground terminal bus, shall be provided on each equipment rack. The ground bus shall be bolted to the rack main metal frame member with 1-inch standoff non-insulating bolts. Provide a minimum of ten drilled and taped bolt holes in the ground bus with ground lug bolts, for connection of equipment grounding conductors to the ground bus, size to accept ground conductors #14-#4AWG.
2. Vertically mounted, cable management metal rings (aluminum or stainless steel) shall be provided full height, continuously along the front and rear of each vertical rail of the equipment rack. The rings shall be bolted to the equipment rack. The rings shall train and dress portable patch cords connecting between outlet connectors located in the equipment rack or in adjacent equipment racks.
3. Provide horizontal cable management panels with multiple cable training rings on each panel (not less than five rings for each panel). Management panels (for up to twenty-four outlet grouping) nominal 19-inches wide by 1.75-inches high by 3-inches deep and/or (for up to forty-eight outlet groupings) 3.5-inches high by 3 inches deep, for EIA rack installation. Rings shall provide horizontal routing and support by grouping portable patch cords connecting between patch ports in the same equipment rack or adjacent racks. Patch cords shall be grouped and bundled with “Velcro” tie wraps and shall not overlap patch fields or rack mounted equipment. The cable management panels shall be installed on both the front and rear of the equipment racks, mounted both above and below horizontally between groups of patch ports as follows:
   a. One cable management panel (front and rear of rack) for each group of forty-eight or less copper wire outlets for patch ports.
   b. One cable management panel (front and rear of rack) for each group of forty-eight fiber optic outlet patch ports.
4. The entire rack assembly including any support arms shall comply with seismic earthquake requirements for install location structural standards.
   a. The assembly shall provide support for the weight of the equipment installed on the rack, but in no case less than 500-pounds of equipment, plus the weight of the rack and connecting cables. A 2.0 time’s safety factor shall be included in the equipment rack assembly structural design.
5. Provide plug strip Transient Voltage Surge Suppressors with RF Suppresser (TVSS) and Power Distribution Units (PDU). Horizontal strip, mounted in each equipment rack. Each unit shall contain not less than six “plug-in” on the rear of the TVSS and not less than two plug-in on the front of the TVSS protected outlet plugs.
   a. Provide two TVSS/PDU units in each equipment rack, to supply “dual-corded” equipment.
6. Provide pre-drilled mounting holes the entire length of equipment vertical mounting frames, EIA-310D-19 inch (nominal) wide standard spacing for indicated equipment. Racks shall provide 17.75-inches (nominal) equipment horizontal mounting space between vertical rails.
7. Provide all floor standing equipment racks with wall bracket support arms extending from the stationary portion of the rack to adjacent wall. Provide "dual-rail arm" cable “runway tray”, horizontally from each equipment rack, to the wall directly behind the equipment rack
   a. The tray shall extend from and bolt to the top of the equipment rack “fixed” top rail.
   b. The tray side rail arms shall be a minimum of 6-inches deep, with "ladder" type rungs spanning horizontally between the side rail arms. The rail arms shall be parallel with each other. The rail-to-rail arm spacing shall be the same as the equipment rack width.

c. The rungs shall be spaced not more than 6-inches on center between the side rails, along the length of the side rail arms. The rungs shall have a minimum cable-bearing surface of not less than 0.75-inches, lengthwise along the tray.
d. The runway tray shall support a minimum of 200 pounds per linear foot live conductor/cable loading, with not more than 0.25-inches deflection at mid-span.
e. Provide a continuous horizontal support "C" channel along the wall behind the equipment racks and bolt the dual-rail arm cable runway tray to the channel at the wall. The channel elevation on the wall above the finish floor shall support the runway tray horizontally (± 0.2-inches), from the equipment rack to the wall.
f. Equipment racks shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
g. The wall mounted horizontal support channel shall be securely through bolt to wall structural member, a minimum of 16-inches on center. The horizontal support channel shall extend a minimum of 6-inches past each side of the runway tray. Support channels as manufactured by Unistrut-P1001C Series; or B-Line; or Kindorf.

8. Provide a copper ground – bus for equipment bonding, in each equipment rack.
9. Equipment racks shall be Manufacturer's standard rust inhibitor primer. Manufacturer's standard color finish paint over primer, unless noted otherwise.

B. Swing Gate Open Equipment Rack Style:

1. Combination wall and floor mounted rack frame nominal 78-inches of usable equipment vertical space for mounting equipment into the rack. The equipment mounting portion of the rack shall be a hinged gate frame assembly. The rack shall provide access to the rear of the installed equipment, the wall behind the rack assembly and wall mounted terminal blocks, when hinged open.
2. The gate assembly shall hinge open not less than 90 degrees from the closed (normal position) on a fixed frame combination floor/wall mounted support structure. A positive latching mechanism shall lock the gate in the fully open and fully closed positions. The rack construction shall allow opening the swing gate, with the installed equipment depth, without obstruction. The fixed stationary portion of the swing gate rack assembly shall be supported from both the fixed floor bracket and wall located behind the rack with adjustable length "dual rail arm" wall brackets. The arms shall provide field adjustment (approximately 24-inches) of the equipment rack spacing from the wall behind the rack. Provide a minimum of two support arms for each swing gate equipment rack.
3. The rack assembly shall be constructed of extruded metal; aluminum gold irradiates finish, or hot dip galvanized steel. Bolted or welded assembly. Hardware shall be stainless steel.
4. Provide steel caster rolling wheel support on the bottom rail of the moveable swing gate frame. The wheel shall provide additional support, but not the main support, of the moving gate assembly and rack mounted equipment along the floor travel "outside arc" of the gate in the open or closed position. The vertical height of the wheel assembly shall be adjustable ±3 inches.
5. Swing gate equipment racks as manufactured by B-Line; or Saunders; or Hendry.

C. Floor Standing Equipment Rack Fully Metal Enclosed Style:

1. Floor mounted self-supporting rack, nominal 80-inches high by 24-inches deep, by 24-inches wide. Internal bolted or welded hot dip galvanized steel or gold irradiate finish aluminum, support frame. Metal enclosed with screw attached removable metal panels. Manufacturer's standard finish color.
2. The front and rear of the rack shall be a full height hinged door, opening not less than 90 degrees from the closed position. The doors shall be readily removable with positive latching mechanism to lock to the doors in fully open or fully closed positions. Doors shall be pad-lockable. Rack shall provide a minimum of 4-inches of clear space between front door and internal mounting face for rack mounted equipment. Smoke/grey impact resistant, tamper resistant see-through windows in the doors, front and rear. Hardware shall be stainless steel.
3. Provide six 120-volt 60Hz AC motor direct drive air ventilation, "muffin" style, nominal 4-inches square, exhaust air fans. Flush mount fans in the top of each equipment rack. The fans shall be low speed, low noise type with wire guards to prevent accidental contact with the fan blades.

The fan motor shall be high impedance, self-protecting type motors. Provide "SO" cord with plug caps to connect from the fans to the 120 volt plug-strip in the equipment rack.

4. Provide cooling air intake louver with a removable 19-inches wide air filter and air filter holder, mounted in the bottom of the rack front nominal 6-inches high.
5. Floor standing metal enclosed equipment racks as manufactured by Stantron; or BUD; or equal.

D. Fixed Position Floor Standing Open Frame Equipment Racks:

1. Floor mounted self-supporting rack, nominal 78-inches of usable mounting frame height for equipment.
2. Bolted or welded hot dip galvanized steel or gold irradiate finish aluminum support frame. Hardware shall be stainless steel.
3. Open frame rack construction, fixed, non-swing gate.
   a. “Two-post” style for equipment racks not designated as containing UPS equipment nor server equipment.
   b. “Four-post” style for equipment racks designated as containing UPS equipment and/or server equipment.
4. Open frame equipment racks as manufactured by B-Line; or Saunders; or Hendry.

E. Floor Standing Modular Frame Equipment Racks

1. Provide a modular frame equipment rack, bolt together modular rack system with all accessories for a completely assembled equipment rack unit. The rack system, when configured for specific equipment, shall support and organize network servers, keyboards, printers, tape drive units, RAID units, CRT's, UPS units, telephone switching equipment, desk top work spaces, etc.
2. Nominal overall dimensions 31-inches deep by 72-inches wide by 84-inches high. Left/right or right/left orientation as indicated on Drawings. Minimum weight capacity of the entire rack assembly shall be 1500 pounds.
3. Manufacturer's standard finish painting, crème white color for metal surfaces. Horizontal flat support surfaces shall be post-formed, laminate top finish, white color.
4. "8L-01/8L-02" vertical support upright assemblies; shall be slotted the full height to "hook-on", lock in and support adjustable height (in 1-inch increments), modular components, with integral floor support "feet". Open back frame - "LF31". Minimum of three vertical support and open back frames in each complete assembly.
5. Provide vertical (on upright supports) and horizontal (on modular "hook-on" components) wire management raceways integral to the assembly.
6. Network server configuration - equipment rack unit:
   a. "LE28" computer tower "roll-out" horizontal floor shelf; nominal 47-inches wide by 24-inches deep. Shelf shall pull out on "ball-bearing" rails, with 23-inch extension for access to computers. Provide one tower shelf for rack unit. Minimum weight capacity 750 pounds. Mount at floor.
   b. "LE25"-computer tower horizontal shelf with ±12 inch end panels and two shelf support brackets; nominal 47-inches wide by 22-inches deep, fixed mounted. Provide one tower shelf for rack unit. Minimum weight capacity 500 pounds. Mounting height ±30-inches.
   c. "LB32" horizontal work surface; nominal 24-inches wide by 27-inches deep. Provide one work surface assembly for each rack unit. Minimum weight capacity 300 pounds. Install on left or right side of rack as shown on Drawings. mounting height ± 28-inches.
   d. LF10/LF11/W162 - General equipment shelf; nominal 72-inches wide by 15-inches high by 16.7 inches deep, with two horizontal shelf surfaces, full width of rack, ± 10-inches nominal vertical height between shelves and five vertical shelf dividers. Minimum weight capacity 300 pounds. Provide one general equipment shelf assembly for each rack unit. Mount at top of rack.
   e. "LA-09" - Keyboard platform. Retractable keyboard platform with auxiliary mouse pad and up-down 15 degree adjustable tilt and adjustable 360 degree swivel. Nominal 23-inches wide by 11 inches deep. Provide three keyboard platforms for each rack unit. Install below, upper tower computer shelf and work surface.

F. Plug Strip Transient Voltage Surge Suppressor (TVSS).
   1. General
      a. Self-contained unit combining plug-in receptacle strip and TVSS. Rated 20 ampere, nominal 120-volt +10%, 60Hz, AC, 2400 watts full continuous load. Internal 20 ampere resettable overload protection circuit breaker. Red illuminated on-off switch. 9-foot, 12AWG 3-conductor grounded, high abuse heavy duty jacketed AC, line cord with NEMA 5-20P cap.
      b. Multi-outlet receptacles, suitable for use with the following types of plug in loads; data processing equipment, audio/video equipment, test instruments, medical equipment, photo graphic equipment and "switching type" power supplies.
      c. Protected 120-volt outlets shall be NEMA 5-15R 15 ampere, or 20 ampere NEMA 5-20R AC 60Hz receptacles, as applicable for connected equipment loads. Provide not less than eight protected outlet plugs on each unit. Each individual or group of two receptacles (duplex) shall be connected to separate protected load isolated filter banks.
      d. Each duplex shall be isolated from the other output receptacles, minimum isolation of 25dB at 1MHz line to line, line to neutral, line to ground and neutral to ground.
      e. Non-blocking plug-in locations/orientation, for plug-in self-contained "power-brick", equipment power supplies.
      f. As manufactured by Liebert; or TRIPP LITE.
   2. Operation
      Self-contained RFI and EMF shielded housing with mounting slots for temporary mounting of the unit. Protected outlet receptacles shall supply over current protected and filtered, electrical line voltage power to the connected equipment. Line noise RFI and EMI interference filtering suppression, transient voltage surge and spike protection shall occur in all three modes of operation line to ground, line to neutral and neutral to ground rated as follows:
      a. 13,000 ampere, 210 joules (watt-seconds) peak withstands capacity.
      b. Transient response time less than 5-nano seconds.
      c. 140-volt AC RMS initiate spikes suppression 330 volt maximum let through.
      d. RFI and EMI Suppression-Provide spectrum analysis test dB attenuation reports showing RFI filtering over specified frequencies.
      e. Diagnostic indicator lights located on the TVSS housing shall provide alarm alert for each of the following conditions:
         1) Loss of AC power.
         2) Damage, malfunction in the TVSS suppression circuits.
         3) Improper AC electrical outlet wiring.
      f. Standards Testing, Listing and Certification Compliance:
         1) IEEE 587 A and B compliance.
         2) UL 1449 transient voltage surge suppressers.
         3) UL 1363 temporary power taps.
         4) UL 1283 electromagnetic interference filters.
   3. Rack Mounted TVSS
      a. TVSS units installed in equipment racks shall comply with all of the same performance requirements including as follows.
         1) EIA/TIA – Equipment rack horizontal mount style (19-inches or 24-inches as applicable).
         2) Minimum of two front mounted outlets and not less than six rear mounted outlets.
         3) Position in each equipment rack as directed by Owner's Representative.
         4) Provide two TVSS units in each equipment rack, for "dual-corded" network equipment.

G. Power Distribution Unit (PDU)
   1. General
      a. Self-contained unit combining main circuit breaker, multiple plug-in individual circuit breaker branch protection load receptacles, PDU metering status monitoring and network communication. All PDU components self-contained in a NEMA-1 metal enclosure.
      b. Non-blocking plug-in locations oriented for plug-in self-contained "power-brick" equipment supplies.
      c. Standards Testing
         1) UL 60950-1 Information Technology Equipment.
         2) CAN/CSA-C22.2 No.60950-1-03 Information Technology Equipment.

3) FCC, Title 47, Part 15 Subpart B for Class B operation as defined by ANSI Standard C63.4.
4) ROHS Complaint.
5) ISTA Procedure 1A and 2A.

d. Provide two PDU units in each equipment rack, to supply two TVSS units in each equipment rack.
e. Shall be a product of the same Manufacturer as the TVSS unit. As manufactured by Liebert; or TRIPP LITE.

2. System Description
   a. Remote monitoring and/or control capabilities for power distribution at each load/equipment rack level. For data/network equipment line voltage plug-in and TVSS line voltage plug-in electrical distribution.
   b. PDU shall meter and monitor electrical attributes of an individual Rack PDU, including real-time remote and local display of monitoring of aggregate and branch electrical parameters (status, thresholds, alarms) including voltage, ampere, and kW. Rack equipment PDU and Branch load monitoring and control.
   c. Self-contained metering and communications
      1) Local display ampere-meter demand load meter to monitor plug-in demand load and total PDU load.
      2) Digital Fast Ethernet LAN RJ-45 communications port for Ethernet SNMP and IP network monitoring of electrical status. Multi-user site-wide software license, compatible with PC-computer and IP-WEB HTTP protocols.
      3) Provide network array-interface for connection of multiple PDU units positioned in the same location.
   d. Nine foot input power (heavy duty high abuse) cord with appropriate conductors and input NEMA plug-in connection. Provide input overload protection with Hydraulic-Magnetic main input circuit breaker. Provide load output NEMA plug-in branch connection with overload circuit breaker protection for each load receptacle.
   e. Equipment rack mounting horizontal position form factor.
3. Electrical Power ratings shall be as follows and as additionally indicated on Drawings. Refer to Drawings for twist-lock verses straight-blade configurations.
   a. Single main input circuit breaker 30 ampere, 208/120 volt 3-phase 5-wire “WYE” grounded 60Hz AC.
   b. Branch load circuit breakers with a single plug-in receptacles for each load circuit breaker. Balance loads on each circuit phase.
      1) Three 20 ampere 1-pole circuit breaker and three NEMA 5-20R receptacles. Also provide matching caps.
      2) One 30 ampere 2-pole circuit breaker and one NEMA 14-30R receptacle. Also provide matching cap.
      3) Additional circuits and receptacles as indicated on Drawings.
4. Provide heavy duty high abuse flexible copper wire 300-volt insolated 15-feet long jacketed electrical cord. Connect from PDU to wall-outlet receptacle with same electrical rating as PDU. Rated for PDU voltages and amperes.
5. PDU units installed in equipment racks shall comply with all of the same performance requirements including:
   a. EIA/TIA – equipment rack horizontal mount style (19-inches or 24-inches) as applicable.
   b. Position in each equipment rack as directed by Owner’S Representative.
6. Provide two Category-6A 4-pair UTP 15-foot long portable patch cable connects, PDU to respective network patch panel port.

2.11 WALL MOUNT FIBER OPTIC CABLE INTERFACE CABINET (WMIC)

A. General
   1. Metal (14 gauge) enclosure, with full height hinged metal door. Door shall be pad-lockable. Nominal size 12-inches deep by 18-inches wide by 36-inches high. Enclosure shall mount directly on the wall.
   2. WMIC shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.

3. Interface cabinets shall be the product of the same Manufacturer.

B. The WMIC shall provide the following self-contained functions internal to the WMIC enclosure.
   1. Fiber cable splicing for "through splicing" of non-UL listed fiber optic cables, where the cables do not terminate in the building.
   2. Fiber cable management, training and strain relief.
   3. Transition from non-UL flame spread listed fiber optic cable, to UL flame spread listed fiber optic cables where the cables terminate in the building.

C. Cable routing rings shall organize optic fibers in a 360 degree loop inside the WMIC housing and provide cable strain relief.

D. Fiber Optic Splice Trays
   1. Provide fiber optic cable splice trays.
   2. Tray holders shall provide mounting and support for each splice tray.
   3. Provide two splice trays for each group (24 or less fibers per group) fiber optic fibers routed through the WMIC, but in no case provide not less than four splice trays in the WMIC.

2.12 UNIVERSAL SPLICE ENCLOSURES - USE

A. General
   1. The universal splice enclosure shall provide splicing for multiple cables containing multiple, network copper wire conductors or fiber optic fibers.
   2. The enclosure with the connecting cables installed shall be water tight, continuously submersible in up to 10-feet depth of water without leaking water into the enclosure interior.
   3. The enclosure with splices shall be completely re-enterable to allow access to the interior splices, adding cables, and removing cables, without compromising the water tight integrity of the enclosure.
   4. The universal splice enclosure assembly shall be UL listed.
   5. The USE shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
   6. USE shall be the product of the same Manufacturer.

B. Fiber Optic Splices
   1. Provide fiber optic splice trays inside the USE. Each splice tray shall provide space for up to 12 splices in lieu of twenty-four splices on the tray.
   2. A splice tray holder shall rigidly anchor splice trays inside the USE, with sufficient slack cable, to allow individual removal of each splice tray.
   3. Provide one splice tray for each twelve fibers passing through the USE, but not less than eight splice trays in the use enclosure.

C. Copper Wire Splices

2.13 SPLICE TRAY FIBER OPTIC FIBERS

A. General
   1. Trays shall be suitable for installation in USE, WMIC, RMSE and RTDE enclosures.
   2. The trays shall be the product of the same Manufacturer as the respective enclosures.
   3. Splice trays shall be UL listed, complying with national Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.

B. Splice Trays
   1. A metal or non-metal splice tray shall provide space for up to twenty-four splices of individual fiber cable single mode and multimode optical fibers. The trays shall provide individual splice holder inserts for each splice to adapt the tray for mechanical or fusion splices, with or without splice sleeves.
   2. The tray shall incorporate integral fiber tie down clamps, fiber routing rings, provide strain relief and two full 360-degree fiber loops around the tray perimeter with sufficient slack fiber for

removal of the tray for access and splicing of the fiber cable. The tray shall insure the minimum bending radius of the optical fibers is not violated.
3. Provide a removable clear plastic tray top cover for each tray, to protect and isolate the fibers.

2.14 WORK STATION OUTLETS

A. General
1. Engrave outlet cover plates with the port number corresponding to the port number at the respective terminal block, patch panel, or head-end equipment.
2. The outlet cover plates shall be factory prepunched and formed to accommodate the installed outlet connector with attachment screws.
3. Workstation outlets shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.
4. Workstation outlets shall be the product of the same Manufacturer.

B. Computer/Data Workstation Copper Wire Outlets
1. The outlets shall be the same configuration and type as the corresponding connector provided in the copper wire patch panel outlet, unless noted otherwise.
2. ANSI/TIA/EIA-568C, and related Standards, Addendums and TSB.
3. The copper wire outlet connectors for twisted pair wire connections in computer workstation outlets shall be universal outlet connector RJ-45 type.

C. Telephone/Voice Handset Twisted Pair Wire Connection Work Station Outlets
1. The copper wire outlet connectors provided in telephone/voice handset outlets, shall be universal outlet connector type, unless noted otherwise, ANSI/TIA/EIA-568C and related Standards, Addendums and TSB.
   a. RJ-45 type
   b. RJ-11 type

D. Fiber Optic Workstation Outlets
1. The fiber optic outlet connectors workstation outlets shall be fiber optic fiber interconnection couplers, installed in universal outlet connectors. Provide one coupler for each fiber connecting to the outlet, but in no case less than the following for each outlet and as shown on the Drawing:
   a. Computer workstation data network two couplers and fiber connectors.
   b. Data network server - four couplers and fiber connectors.
2. The universal outlet connector housing and cover plates shall be the same as copper wire outlet connectors, except with adapters for fiber optic interconnection couplers, for the fiber optic fibers plug-in connectors.
3. The centerline-to-centerline spacing of the inter-connection couplers shall provide for "plug-in" insertion of “single or duplex” fiber connectors.
4. Color-code and identify the "in"-receiving and "out"-transmitting position for each interconnection coupler.

E. Outlet Boxes
1. General for Low Voltage Outlets Requirements
   a. Shall be UL approved and labeled for Life-Safety Appliances.
   b. UL listed and label for low voltage CEC/NEC Class-2 wiring and devices.
   c. Shall be adjustable to fit into the wall/ceiling and attach into the wall/ceiling thickness at each install location.
   d. Provide cable “Strain-Relief” attachment and “Sharp-Edge” protection for each outlet cable connections.
2. Wall mounted
   a. Flush or surface wall mounted outlet box and size as indicated on the Drawings, but in no case less than 4.69-inches by 4.69-inches by 2.125-inches deep.
   b. Two gang wide extension ring for outlet box to extend outlet flush with finish surface, or as noted on the Drawings.
   c. Two gang wide cover plate, or as noted on the Drawings.

3. Pedestal Mounted "Poke-Thru".
    a. Shall combine a computer/data and a telephone/voice copper wire universal outlet connector in a duplex outlet in the pedestal/poke-thru outlet.
4. Inside flush floor boxes and other locations where indicated in the Contract Documents.
5. Low Voltage Outlets in Fire rated walls and ceilings
    a. Provide metal outlets for low voltage devices installed (recessed into) in fire rated walls or fire rated ceilings.
    b. Provide metal outlet box enclosed type, for each outlet location. Provide UL labeled and listed “Fire-Wrap” complete coverage protection on the exterior of each outlet box. The combined outlet box and “Fire-Wrap” protection shall be equal or greater than the respective wall or ceiling fire-rating location.
6. Low Voltage Outlets in Non-Fire Rated walls and ceilings
    a. Outlets for low voltage devices installed (recessed into) walls or ceilings, only where the wall/ceiling is not fire-rated.
    b. Provide the following for each outlet location
        1) Metal outlet box, enclosed type. All locations where one or more conduit(s) are required to connect to the outlet, then only metal outlet box shall be provided.
        2) Or device mounting bracket with trim ring, without (backless) enclosed outlet box. Do not use bracket-trim/ring configuration where conduit connection to the outlet with conduit is required, provide metal outlet boxes. Shall provide attachment for low voltage device(s), cover plates and low voltage wire strain relief.
7. Low Voltage outlet installed into accessible suspended ceiling with removable ceiling panels.
    a. Support outlet independent of ceiling supports and ceiling.
    b. Provide a minimum of three independent hanger wires for each outlet. Attach hanger wires to building structure above ceiling and to outlet.
8. Low Voltage Outlets in existing walls and existing ceilings
    a. Outlets installed (recessed into) existing walls or (recessed into) existing ceilings. Cut and patch to match existing surfaces for outlet installation.
    b. Provide “cut-in” retrofit mounting-attachment into existing ceiling/wall construction. Shall be UL rated for retrofit into “old-work”.
    c. Provide the following for each outlet location,
        1) Metal outlet box, enclosed type. Required for all Fire rated construction locations. Also permitted for non-Fire rated construction locations.
        2) Or device mounting bracket with trim ring. Permitted only for non-Fire rated construction locations only where no conduit connection to the outlet is required. Do not use in Fire rated construction locations. Do not use where conduit connection to outlet is required.
    d. Where the existing wall/ceiling existing fire rating is indeterminate, Contractor shall assume the existing fire rating is not less than 2-hours. Provide metal outlet box and Fire-Wrap for each recessed outlet box.

F. Multi-outlet Raceway Work Station Outlets
1. Copper wire outlet:
    a. Where copper wire connection is indicated for the workstation outlet, provide one universal outlet connector for each outlet.
    b. Each universal outlet connector shall be single connector housing type.
    c. Provide a rectangular cutout and metal device plate in the raceway sized to Outlet Manufacturer's recommendations. The workstation copper wire outlet shall mount a modular faceplate kit with outlet bezel and faceplate sized to match the workstation outlet.
    d. Offset the location of outlets for electronic network systems 6-inches in the raceway from other outlets, do not "stack" outlets one above the other in the raceway.
2. Fiber optic outlet:

G. Combination Outlets
1. Infrastructure outlet connectors shown at the same location for either wall box outlet locations and floor box outlets locations.
2. The outlet connectors shall be installed in a common outlet box with a common cover plate in the respective wall location or floor location.
3. In infrastructure patch panels install the connectors in the respective patch panels.

2.15 PORTABLE PATCH CORDS

A. General
   1. Provide portable patch cords for all copper wire and fiber optic cable infrastructure outlets:
      a. For interconnecting electronic network equipment to electronic network workstation outlets.
      b. For interconnecting equipment rack patch panel outlet patch locations with each other.
      c. For interconnecting patch panel outlets equipment rack mounted hubs, switches, routers, telephone equipment, A/V equipment, access control and intrusion detection equipment etc.
   2. Patch cords shall be factory assembled tested and certified with factory terminated plugs at each end. Field terminated portable patch cords shall not be permitted. Terminated plugs shall incorporate integral bending radius limiting molded “boots” and strain relief. Patch cord assemblies shall be rated for "heavy duty", “high-abuse” service.
   3. Patch cords shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements. ANSI/EIA/T1A-568C, related Standards, Addendums and TSB.
      a. NEC - OFNG/OFN for fiber optic portable patch cords.
      b. NEC - MPP/CMP/CMR/CMG/MPG for copper wire twisted pair portable patch cords.
      c. NEC - CATV for coaxial cable portable patch cords.
   4. Patch cords which are not installed shall be delivered to the Owner in cardboard boxes. The patch cords shall be neatly bundled and tied together. Mark each box with quantity and type of cords contained in the box.
   5. Patch cords shall comply with the same cable communication performance, requirements, protocol requirements and testing requirements as the respective infrastructure cables and outlets to which the patch cords are intended to be connected (plug-in). Patch cords shall be the product of the same Manufacturer.
   6. The outer jacket of each portable patch cord shall be imprinted with date, Manufacturer’s model and catalog number and AHJ listing identification.
   7. Provide a permanent, visible, factory applied identification number on each end of each patch cord. The identification number shall be the same on each end. However, the numbers shall increase sequentially on each patch cord and shall be unique and not duplicated on other patch cords. Permanently apply the identification numbers on the cable jacket or connectors.

B. Twisted Pairs, Copper Wire Portable Patch Cords
   1. Twisted Pairs portable patch cords, general:
      a. "Male" eight position modular "RJ" male style jacks install on each end of the patch cord cable. The jack shall be provided with a rear "fin" to prevent the plug tab from snagging when pulled backwards through adjacent wiring.
         RJ-45 style “male” jack, typical unless noted otherwise.
      b. Patch cord cable shall be UTP and ANSI/EIA-Category rating, shall match respective permise wiring, 4-pair twisted, stranded copper individually insulated wires, thermoplastic jacket over all the wires [and shield].
      c. Connectors shall comply with FCC 68.5 and Part 68 Subpart F.
      d. Connectors UL listed and shall comply with UL-94V-O.
      e. Contacts gold plated with not less than a 750 insertion/withdraw cycle rating.
   2. Portable patch cord quantities and lengths for connecting port-to-port equipment rack patch panels
      a. Patch cord quantity: Provide one complete patch cord assembly for each copper wire equipment workstation outlet patch port in the equipment rack patch panels. One-to-one straight through pin-to-pin wiring. Provide additional spare patch cords, quantity equal to 25% of the total quantity of patch cords provided for copper wire computer workstation outlets in the equipment rack patch panels. Cable jacket color shall be blue:
      b. Provide the following lengths of copper wire patch cables for copper wire equipment rack patch panel outlets.
         1) 2-feet long - 10% of total quantity
         2) 4-feet long - 30% of total quantity
         3) 6-feet long - 30% of total quantity
         4) 10-feet long - 20% of total quantity
         5) 16-feet long - 10% of total quantity

3. Portable patch cord quantities and lengths - for connection from equipment workstations to equipment workstation outlets, located remote from equipment racks.
    a. Patch cord quantity: Provide one complete patch cord assembly for each copper wire workstation outlet located remote from the equipment rack patch panels. Provide additional spare patch cords, quantity equal to 15% of the total quantity of patch cords provided for each copper-wire computer workstation outlets. Cable jacket color shall be blue:
        1) Infrastructure network outlet segments the pin-to-pin patch cord wiring configuration and jacks shall be compatible with the equipment protocol communications interface, and the respective workstation outlet.
    b. Provide the following lengths of copper wire patch cables for equipment copper wire infrastructure network workstation outlets. The patch cords shall provide internal cross-over wiring to conform the pin-to-pin connections required between the equipment workstation outlet and the equipment protocol communications interface installed in the respective workstation equipment:
        1) 8-feet long - 30% of total quantity
        2) 15-feet long - 70% of total quantity
4. Portable patch cord quantities and lengths for connection from electronic equipment rack patch panel ports to equipment installed in equipment racks, such as HUB's, servers, switches, router, telephone and concentrator equipment ports. Cable jacket color shall be white.
    a. Patch cord quantity: Provide one complete patch cord assembly for each copper wire outlet port located in electronic equipment. Provide additional spare patch cords, quantity equal to 25% of the total quantity of the equipment rack equipment ports.
        1) The pin-to-pin patch cord wiring configuration and jacks shall be compatible with the respective equipment and patch panel outlets as applicable.
    b. Provide the following lengths of copper wire patch cables for outlet ports located in electronic equipment installed in equipment racks. The patch cords shall provide quantity of conductors, wiring shall conform the pin-to-pin connectors and jack/connectors to the ports in the equipment mounted in the equipment racks.
        1) 4-feet long - 15% of total quantity
        2) 6-feet long - 30% of total quantity
        3) 10-feet long - 35% of total quantity
        4) 16-feet long - 20% of total quantity
5. Portable patch cord quantities and lengths for connection of equipment requiring customized pin-to-pin wiring configurations and/or customized port connector configurations. Cable jacket color shall be tan.
    a. Patch cord quantity: Provide one complete patch cord assembly for each outlet port install as part of the Contract and not identified in any other patch cord descriptions. The patch cords shall be customized and configured to comply with the respective Manufacturers recommendations.
    b. Provide one patch cord for each port-to-port connection length as required for actual installation condition.
        1) Provide 100% spare but not less than one spare patch cord for each custom configuration.

C. Telephone/Voice Copper Wire Portable Patch Cords-110 style
1. 110 style jacks for plugging into the 110 style connecting blocks located in the telephone/voice terminal blocks.
2. Patch cords shall be UTP 4-pair twisted, 24AWG stranded copper individually insulated wires with a thermoplastic jacket over all the wires. Cable shall be ANSI/TIA/EIA-568C.
3. Patch cord quantity and length - telephone/voice terminal block:
    a. Provide one complete patch cord assembly for each copper wire telephone/voice outlet connecting to the telephone/voice terminal block. Provide additional spare patch cords, quantity equal to 25% of the total quantity of patch cords provided for telephone/voice 110 patch cords.
    b. Provide the following lengths of copper wire patch cables for telephone/voice 110 style connecting block portable patch cords.
        1) 3-feet long - 25% of total
        2) 5-feet long - 50% of total

3) 15-feet long - 25% of total

D. Coaxial Cable Portable Patch Cords
   1. BNC type connectors on each end of each patch cord. Shall be compatible with patch panel outlets, workstation outlets and respective equipment rack electronic equipment.
   2. Patch cord quantity: Provide two complete patch cord assemblies for each coaxial cable outlet.
      a. One patch cord for workstation outlet located remote from the equipment rack patch panel, 15-feet long each patch cord.
      b. One patch cord for equipment rack (IDF/MDF) patch panel each outlet location, 10-feet long each patch cord.
      c. Provide 15% additional spare patch cords of each patch cord length.

E. Fiber Optic Portable Patch Cords
   1. General
      a. Provide fiber optic fiber connectors installed on each fiber end of the patch cord cable. The fiber optic portable patch cord shall be “single” with one fiber strand “duplex” with two fiber strands type, for each patch cable. The connector shall be mechanically and optical compatible with the respective connecting patch panel couplers and network work equipment couplers.
      b. The entire patch cord assembly total insertion loss shall be less than 1.0dB at the specified operating wavelengths.
      c. Operating temperature range 30-degrees centigrade through +60 degrees centigrade. Cables shall be flame retarding.
      d. Each fiber shall be individually identified with factory color-coding and factory imprinted label. The outer cable jacket shall be imprinted with date, Manufacturer's model and catalog number, along with agency listing identification. The cable jacket color shall be yellow.
      e. All fiber optic patch cord cable shall be a product of the same Manufacturer.
      f. Optical fiber shall be coated, 900 micron diameter uniform coating, with uniform tight buffering over the coating, uniform dielectric strength member surrounding the buffering coating and an overall jacket around each optical fiber assembly.
      g. A dielectric strength member shall surround the fiber assemblies.
      h. An outer dielectric jacket shall envelope the entire cable.
      i. The cable shall be UL listed and comply with NEC and NFPA requirements for each installation location shown in the Contract Documents.
      j. Patch cord quantity and length
         1) Patch cord quantity: Provide one complete patch cord assembly for each fiber optic patch panel outlet in the equipment rack.
         2) Provide one complete patch cord assembly for each computer workstation fiber optic outlet remote from the patch panel.
         3) Provide additional spare patch cords, quantity equal to 25% of the total quantity of patch cords provided.
      k. Provide the following quantities and lengths of fiber optic patch cords.
         1) 3-feet long - 20% of total
         2) 6-feet long - 35% of total
         3) 10-feet long - 30% of total
         4) 20-feet long - 15% of total
   2. Multimode patch cords
      a. Patch cord cable shall be fiber optic cable with equal or better characteristics as the premise fiber optic cables.

2.16 CIRCUIT PROTECTORS

A. General
   1. The circuit protectors shall be UL listed, complying with National Electrical Code, ETL Tested and Certified to comply with or exceed specified requirements, ANSI/TIA/EIA-568C including related Standards, Amendments and TSB.

B. Circuit Protectors

1. Cables containing non-dielectric electrical conducting components entering from the exterior of the building shall be provided with individual circuit protectors combining both lightning circuit protection and TVSS circuit protection on each circuit conducting component, as required in NEC Articles 770 and 800.
2. Install circuit protectors in the respective backboard/equipment rack where copper wire conductors terminate, connect each protector to room/closet ground bus equipment with #10AWG green insulated bond/ground copper conductors.

PART 3 EXECUTION

3.1 NETWORK CABLE TESTING AND COMMISSIONING (ADDITIONAL REQUIREMENTS)

A. General

1. In addition to the testing recommended in ANSI/TIA/EIA-568C and related Standards, Amendments and TSB. End-to-End test 100% of all individual optical fiber, individual copper wire conductors, each outlet and each connector in all terminated and unterminated cables, portable patch cord, outlets and patch panels provided in the Contract, shall be tested after installation as a complete channel pathway installation, splicing outlets and termination is completed, including the following end-to-end tests on each installed individual circuit;
   a. Each circuit wire and fiber map and length
   b. Each circuit insertion Loss
   c. Each circuit NEXT (Pair-to-Pair) Loss
   d. Each circuit NEXT Loss (Power Sum) PS
   e. Each circuit ELFEXT Loss (Pair-to-Pair)
   f. Each circuit ELFEXT Loss (Power Sum) PS
   g. Each circuit return Loss (RL)
   h. Each circuit propagation delay
   i. Each circuit propagation delay-skew
2. The test equipment and (Tester) shall comply with the accuracy requirements for Field Testers as defined in the ANSI/EIA/TIA Standards for the specific cable type. The Tester including the appropriate interface adapter shall meet the specified accuracy requirements. The Tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy. The Tester shall be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The CONTRACTOR shall provide proof that the interface has been calibrated within the period recommended by the Vendor.
3. The Pass or Fail condition for the channel pathway link-under-test is determined by the results of the required individual tests (ANSI/EIA/TIA) any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass. A Pass or Fail result for each parameter is determined by comparing the measured values with the ANSI/EIA/TIA test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field test. The Field Test Equipment Manufacturer shall provide documentation as an aid to interpret results marked with asterisks.
4. Provide all test equipment, Certified Testing Personnel, and setups. Shall comply with ANSI/ EIA/TIA and Equipment Manufacturer's recommendations and standards of practice.
5. Provide six copies of all test reports, bound in three ring binders. Provide three digital CD/DVD ROM copies. Organize test reports into rows-and-columns spread-sheet format, with data common groupings by IDF and NDF location. Submit to Owner's Representative.
6. The Contractor shall repair or replace equipment, cables, outlets, connectors, splices, terminations, etc. identified during testing as not complying with the Contract Documents, without additional cost to the Contract. Retest all replaced or repaired components at Contractor's expense.

B. Twisted Pair Copper Wire Testing

1. Channel insertion loss (dB).
2. Channel near-end cross-talk NEXT loss (dB).

3. Channel equal-level far-end cross-talk ELFEXT (dB).
4. Channel return loss (dB).
5. Channel power sum PSACR (dB).
6. Channel propagation delay, propagation speed, and delay skew.
7. Channel wire map and circuit length.
8. Channel ring-out test for continuity and correct point-to-point matching terminals.
9. Channel DC resistance and capacitance.
10. Channel attenuation-to-cross-talk ratio ACR.

C. Coaxial Cable Testing

1. Channel full specified frequency spectrum attenuation insertion loss (dB).
2. Channel wire mapping, ring-out and circuit length.
3. Channel propagation delay and propagation speed.
4. Channel impedance and continuity for center conductor and shields.

D. Fiber Optic Cable Testing, Optical Testing for Each Specified Wave-Lengths for Both laser and LED sources.

1. Channel link insertion losses (dB) OLTS.
2. Channel loop-back attenuation (dB).
3. Channel signature Optical Time Domain Reflectometer – OTDR, for installation characterization testing (event and attenuation resolution dead zone at specified wave lengths, shall be less than 10-feet).
4. Channel continuity and correct point-to-point matching terminals.
5. Channel propagation delay and propagation speed.
6. Channel fiber optic mapping, circuit length, and tracing.

3.2 FIBER OPTIC CABLE TYPE

A. General

1. Cables shown as fiber optic type shall comply with the following installation locations.
2. Provide matching compatible outlets and terminate all fiber optic cables into matching fiber optic connectors.
3. Fiber optic cable installed in indoor locations without enclosed raceway or conduit.
   a. Provide non-metallic, flexible corrugated continuous inner duct-raceway and install fiber optic cable in the innerduct.
   b. Innerduct shall be heavy duty, plenum-rated, Limited-Combustible (LC) type UL FHC – 25/50, orange color. Support innerduct 36-inches on center, independent of ceiling supports and independent of other equipment supports.
   c. Innerduct size shall be selected to insure percentage-fill with fiber optic cables shall not exceed 30%, but in no case less than 1.25-inch diameter innerduct.

B. Provide loose tube gel filled or indoor/outdoor type fiber optic cable for any of the following installation location conditions.

1. Inter building (between buildings)
2. In a conduit or raceway located underground below grade.
3. In an exposed outdoor conduit or raceway not located underground or below grade.
4. Do not install loose tube gel filled type fiber optic cable inside a building or exposed on a building without providing Rigid Steel (RGS) conduit raceway for the loose tube gel filled fiber optic cable along the entire length of the cable inside the building or on the building.

C. Provide tight buffered or indoor/outdoor type fiber optic cable for any of the following installation location conditions.

1. Intra-building (inside a building) where raceway continuously encloses the cable and the raceway is not located underground, below grade.
2. In an exposed outdoor conduit or raceway not located underground or below grade.

D. Provide plenum rated type fiber optic cable for any of the following installation location conditions in building spaces.
   1. Any building space air plenum (supply or return) when a conduit or enclosing raceway is not provided for the entire cable length. Additionally, Cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.
   2. All building space locations where the cable is installed without a conduit or the cable is not fully enclosed in a raceway along the entire cable length in a building. Additionally, Cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.
   3. Building spaces and/or cavities that are 100% fully protected with fire sprinklers, including fire sprinklers located above in ceiling cavities and fire sprinklers located below in access floor cavities. Cables installed in these locations shall be rated with one or more of the following additional characteristics.
      a. Limited–Combustible (LC) UL FHC-25/50 plenum rated cable.
      b. Or plenum rated cable without the UL FHC-25/50 Limited-Combustible (LC) rating.

E. Optical Fiber Quantity:
   1. The minimum fiber quantities in each fiber optic cable shall be as follows, but in no case less than indicated on the Drawings.
   2. Between main IDF (SUB-MDF) in separate buildings and the MDF main terminal rack fiber optic patch bay for the entire site/campus.
      a. Twenty-four optical fibers, multimode plus six optical fibers, single mode.
   3. Between satellite IDF terminal rack fiber optic patch bays and the main terminal rack IDF (sub-MDF) patch bay located in the same building.
      a. Twenty-Four optical fibers, multimode plus six optical fibers, single mode.
   4. Between a terminal rack patch bays (IDF or MDF):
      a. To an individual workstation outlet located inside the same building - two multimode optical fibers, (typical only for locations where fiber is specifically shown on the Drawings for the specific work station outlet).
      b. To each network file server outlet location whether or not shown on the Drawings, four optical fiber, and multimode.
   5. Between a terminal rack patch bay and individual multimedia network (television/video/audio) workstation outlets and/or intrusion/access program display devices located inside the same building - two optical fibers, multimode.
   6. Other locations as indicated on the Drawings or described in the Contract Documents.

3.3 COPPER WIRE CABLE TYPE

A. General
   1. Cables shown as copper wire type shall comply with the following installation conditions, unless noted otherwise on the Drawings.
   2. Provide matching compatible outlets and terminate all copper wire cables into matching copper wire connectors.

B. Cable Types and Quantities - Cable types and quantities shall be as follows unless specifically noted otherwise on the Drawings. The following minimum type and quantity of copper wire cables from each individual workstation/device outlet, to the respective terminal equipment patch panel/ bay, (unless specifically noted otherwise), but in no case less than what is shown on the Drawings and in no case less than one 4-pair cable to each outlet “Jack” position:
   1. Two Category-6, UTP 4-pair cable:
      a. Each network workstation outlet location.
      b. Each network “wireless-access-point” outlet location.
   2. One Category-6 UTP 4-pair cable, for each telephone handset (instrument) workstation outlet location.
   3. Trunking-Cables shall be Category-5E.
      a. 100-pair between buildings main IDF (SUB-MDF) and campus main MDF.
      b. 50-pair inside building between SUB-IDF to buildings main IDF (SUB-MDF).
   8. Other locations as indicated on the Drawings or described in Contract Documents.

C. Provide plenum rated copper wire cable for any of the following installation location conditions in building spaces.
   1. Any air plenum (supply or return) when a conduit or enclosed raceway is not provided for the entire cable length. Additionally, cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.
   2. All building space locations where the cable is installed without a conduit or the cable is not fully enclosed in a raceway along the entire cable length in the building. Additionally, cables shall be rated Limited-Combustible (LC) type UL FHC-25/50.
   3. Building spaces and/or cavities that are 100% fully protected with fire sprinklers, including fire sprinklers located above in ceiling cavities and fire sprinklers located below in access floor cavities. Cables installed in these locations shall be rated with one or more of the following additional characteristics.
      a. Limited–Combustible (LC) UL FHC-25/50 plenum rated cable.
      b. Or plenum rated cable without the UL FHC-25/50 Limited-Combustible (LC) rating.

D. OSP Insulated Copper Wire Cables
   1. Outside – Plant (OSP) CEC/NEC rated, UL listed, labeled and approved insulated copper wire cable assemblies. Moisture barrier resistant and UV resistant cable jacket. Non-flammable, water blocking, non-conductive gel internally filled infrastructure cable assembly.
   2. Provide rated insulated copper wire OSP type cable for any of the following copper wire infrastructure cable install locations.
      a. In underground conduit or in conduit under the building.
      b. In conduit exterior to the building, or in conduit exposed outdoor on the building.
      c. Outdoor aerial with aerial messenger wire cable carrier.
   3. Except for aerial install locations, install all OSP cable in continuous conduit pathways, end-to-end.

3.4 CABLE INSTALLATION

A. General
   1. Cables connecting to equipment racks and terminal blocks shall be installed with not less than 6-feet of slack cable between the equipment rack/terminal block and terminal backboard. The slack cable shall be coiled and supported on the backboard and/or cable tray.
   2. Cables in terminal closets and terminal rooms shall be trained, dressed and racked on the plywood backboards. Provide cable, metal support arms and re-enterable type cable support rings not less than 12-inches on center mounted onto the plywood along the entire length of all cables.
   3. Provide separate routing paths on plywood backboards for fiber optic cables, computer data and copper wire cables and telephone/voice copper wire cables and multimedia, audio/video, TV cables. Provide separate routing paths on plywood backboards for shielded copper wire cables and unshielded copper wire cables.
   4. Cables shall be routed parallel to floors and walls. Do not route cables diagonally on backboards.
   5. Spare cable slack
      a. Provide 25-feet of cable slack where unterminated cables are specified at terminal backboards.
      b. Provide a minimum of 18-inches of slack cable in each workstation outlet box and outlet locations.
      c. Provide 10-feet of cable slack in ceiling above each work station outlet.
      d. Provide 24-inches of slack in each cable at patch panel locations.
      e. Coil and "Velcro" wrap slack cable.
   6. Provide “horizontal wiring” cables installed from individual equipment locations and workstation outlets to respective MDF/IDF terminal closet/room patch panel. Cables shall be continuous without cutting or splices.
   7. Provide “backbone” cables installed from each IDF location to respective MDF/ Sub-MDF location terminal closet/room patch panels. Cables shall be continuous without cutting or splices.

B. Cable Pulling Lubrication

1. Cable pulling lubricants shall be specifically approved by the Cable Manufacturer. The following lubricants shall be used where approved by the Cable Manufacturer.
   a. Slip X -300, American Colloid Co.
   b. Bishop #45, Bishop Electric.
   c. MacLube CA51, MacProducts.
   d. Minerallac H2B,- Minerallac Electric.
   e. Winter grade #7437-PC, General Machine Products.
   f. Gel-lube 7/5, Cable associates.
   g. Polywater , A, C, G - American Polywater.
2. Lubricants shall be continuously applied as cable enters raceway.

C. Cable Installation:

1. Do not pull conductors until factory test reports have been submitted and reviewed.
2. Minimum bending radius of fiber optic cables shall not be less than the following. Maximum pulling tension shall not exceed the following. In no case shall the Manufacturer's recommendations be violated.

Cable Type	Cable Fiber Quantity	Minimum Bend Radius	Maximum Pulling Tension
Loose Tube	2-84	9 inches	600 pounds
Loose Tube	86-192	10 inches	600 pounds
Tight Buffered	2-12	5 inches	400 pounds
Tight Buffered	14-24	7 inches	600 pounds
Tight Buffered	26-28	11 inches	1100 pounds
Tight Buffered	48-72	12 inches	1200 pounds

3. The minimum bending radius for copper wire cables shall be 10 times the cable outside diameter. The maximum pulling tension and minimum bending radius shall not violate Manufacturer's recommendations.
4. Cables installed in manholes and pullboxes on terminal backboards shall be installed on wall mounted cable support racks.
5. Provide a full 360-degree loop of cable around manhole and pullbox interiors.
6. The attachment of pulling devices directly to the cables shall be with individual split mesh basket grips. Direct connection for pulling cables to cable fibers and copper wires shall not occur. Securely tape cable ends to prevent moisture or pulling compound from penetrating cable.
7. The attachment of the pulling device to the cable basket grips shall be made through a swivel connector.
8. The Contractor shall ensure that the cables are fed straight into the raceway taking care to avoid short bends, sharp edges and cable "cross-overs".
9. All lashings used for temporary bunching of the individual cables shall be removed before the cables enter the raceway.
10. Cables shall be "pulled through" or pulled from a "center of run pull" without splices or terminations and minimize cable rolling tension. Lead-out the cables at all manholes, pullboxes and conduits taking care to feed them in again by hand for the next portion of the cable run.
11. For each cable pull where a cable direction change is required, flexible feed-in tubes, pullout devices, multi-segmented sheaves etc. shall be used to insure proper cable pulling tensions and side wall pressures. Cables shall not be pulled directly around a short right angle bend. Any device or surface the cable comes in contact with when under pull-in tension shall have a minimum radius 50% greater than the final specified minimum installed cable bending radius. The maximum possible size radius sheaves and feed-in tubes, usable in the available working space, shall be provided in all situations, to insure the minimum possible cable side-wall pulling pressure. Do not use devices with multi-segment "roller" type sheaves.
12. Cable lengths over 50 feet shall be machine pulled not hand pulled into and through all raceways. Cables shall be pulled in a continuous, smooth operation without jerking or stop-start motion after initiation of pull. Maximum cable pulling speed shall be less than 50 feet per minute. Minimum cable pulling speed shall be greater than 15 feet per minute.
13. Cables shall be pulled straight into or out of the raceway without bends at the raceway entrance or exit. Pull in cable from the end having the sharpest bend (i.e., bend shall be closest to reel). Keep pulling tension to minimum by liberal use of lubricant, hand turning of reel, and slack

feeding of cable into duct entrance. Employ not less than one man at reel and one at manhole or pull-hole during this operation. Cables shall be pulled directly from cable reels.

14. Cables shall be trained or racked in trenches, vaults, manholes and pull boxes with consideration given for the minimum specified bending radius of the cable and the possibility of cable movements due to load cycling. The cables shall be racked and supported in such a manner that adequate space is allowed for splicing and the cables shall always be fanned out from the duct or conduit so as not to cross other ducts, conduits or cables. To prevent damage from falling objects or personnel entering the manhole the cables shall not pass directly under the manhole opening.
15. Cable shall be supported in manholes, pull boxes and vaults a minimum of 18-inch on center with cable racks. Provide hot dip galvanized, T-slot racks and support arms. Secure cables to racks with porcelain supports for each cable on the racks. Loosely lash cables to racks. Splices shall be directly supported, on racks. Do not install cables more than one (1) feeder on the same rack hook.
16. Cables shall be routed the long way around manhole, pull-hole, etc. with not less than a full 360-degree loop around the perimeter walls unless noted otherwise.
17. Existing conductors shall be protected at all times when Contract work occurs in the same area, including but not limited to pullboxes, vaults manholes, cable trenches etc. Provide temporary electrical insulating blankets and barriers over existing conductors to reduce the possibility of accidental mechanical damage to existing conductors.
18. Where cable tray is provided, all cables shall be routed and trained on the cable tray. The cables shall enter the cable tray and route along the tray prior to entering any equipment racks or computer works station outlets.
19. A dynamometer to measure pulling tension shall be used on all cable runs in excess 200-feet or with more than 180 degrees in bends. The actual pulling tension value shall be calculated and recorded for each pull.
20. Bends shall not be made in cable splices or terminations.
21. The portions of cables installed without raceways or cable tray supports shall be installed with metal “J-hook” cable supports.
    a. The “J-hooks” shall provide multi-tiered “J” shaped hooks, with wide flat cable support base (0.5 inch wide minimum) and smooth rounded corners. Specifically designed for copper wire and fiber optic infrastructure cable support as manufactured by Erico Inc.
    b. The individual “J-hook” attachment to the building structure shall be metal, “beam clamp”, “hanger rod”, clevis hanger styles as applicable for each attachment location.
    c. Install “J-hooks” not more than 48-inches on center along the entire cable length and within 6 inches of each cable change in direction. Locations of “J-Hooks” and tension of cables shall insure between 4-inches and 6-inches of cable sag between adjacent hooks. Secure cables to “J-hooks” with re-enterable cable tie wraps. “J-hook” supported cables, bundle cables together with re-enterable tie wraps not less than 12 inches on center along the entire cable length.
    d. Each J-hook shall not support more than 12 individual cables. Provide multiple “tiered” J-hooks for additional cable quantities at each location.
    e. “Bridle rings” shall NOT be used to support cables.
    f. Cables shall not lie directly on nor attach to ceilings, ceiling hangers, lighting fixtures, air ducts, piping, or equipment.
22. Re-enterable cable tie wraps shall be, “limited-combustible” and air plenum rated, reusable, color coded. Chemically and mechanically compatible with the respective cables and install locations. Shall allow multiple open-close operations for securing cables.
23. Electronic network cables containing non-dielectric components shall be installed with a minimum separation from other electrical power conductors and equipment as follows:

	Equipment Type	Minimum Separation
a.	Lighting fixtures	12 inches
b.	Electric motors, electric solenoids, electric Heaters	40 inches
c.	Transformers	48 inches
d.	Circuits over 100 volts to ground, in metallic raceways	5 inches
e.	Circuits over 100 volts to ground, in non-metallic raceway or without any raceway	12 inches
f.	Circuits over 100 volts to ground, suspended on overhead pole lines	48 inches

D. Movement, Storage, and Handling of Cable:
   1. Reels of cable shall not be dropped from any height, from trucks or other transporting equipment.
   2. Lift and move cable reels using following methods:
      a. Crane or boom type equipment-insert shaft (heavy rod or pipe) through reel hubs and lift with slings on shaft, with spreader or yoke to reduce or avoid sling pressure against reel head.
      b. Forklift type of equipment may be used to move smaller, narrower width reels. Fork tines should be placed so that lift pressure is on reel heads, not on cable, and shall reach all the way across reels so lift is against both reel heads.

      c. Reels may be moved short distances by rolling. Reels shall be rolled in the direction indicated by arrows painted on reel heads. Surfaces over which the reels are to be rolled shall be solid clear of debris, and also clear of protruding stones, humps, etc. which might damage the cable if the reel straddles them.
   3. Storage of reels of cable:
      a. Cable ends shall be sealed prior to shipment to prevent moisture entry into cable. Cable ends shall remain sealed at all times including during installation. Where ends seals are removed, reseal cable ends by stripping cable finishes back 2-inches down to insulation. Then apply four layers of an insulating tape criss-cross over the cable end and carry back at least 4-inches onto cable outer finish. Add a containing cover of two layers of vinyl electrical tape completely over the end seal.
      b. Cable reels shall be shipped with factory applied lagging (protective cover) left in place until removal is absolutely necessary. Additional covering such as tarpaulin, plastic sheeting, etc. shall be used if cable is to be stored outdoors.
      c. Store reels of cable on a firm surface, paved, or on planking to prevent settling into soft ground.
      d. Use fencing or other barriers to protect cables and reels against damage by vehicles or other equipment moving about in the storage area.

3.5 CABLE SPLICES

A. General
   1. Splice(s) in cables shall occur only in the following locations:
      a. Pullboxes or manholes.
      b. Terminal backboard, closets or rooms.
      c. Equipment racks.
      d. Wall mounted interface cabinet.
      e. Do not splice cables in conduit, cable tray, raceways or plenums.
   2. Polarity and color-coding shall be maintained consistent through splices, terminations and outlets for the entire electronic network system.
   3. Cable splices in outdoor areas, manholes, pullholes shall be water tight, inside universal splice enclosures.

B. Fiber optic cable splices unless specifically indicated otherwise below, fiber optic cable splices between fiber optic cables fibers shall be fusion type splices.
   1. Splices between loose tube gel filled fiber optic cable fibers shall be fusion type splices.
   2. Splices between indoor/outdoor fiber optic cable fibers shall be fusion type.
   3. "Pigtail" splices of tight buffered and indoor/outdoor fiber optic cable fibers to loose tube gel filled cables shall be fusion type splice.
   4. Splices between tight buffered fiber optic cable fibers to indoor/outdoor fiber optic cables shall be fusion type splice or mechanical type splice.
   5. Splices between tight buffered fiber optic cable fibers shall be mechanical type splice or fusion type splice.
   6. "Pigtail" splices of tight buffered fiber optic cable fibers to tight buffered fiber optic cable fibers shall be mechanical type splice or fusion type splice.
   7. Fiber optic splices shall be performed to maintain the data transmission rates specified for the entire respective system.

C. Copper Wire Splice

1. Copper wire extending from infrastructure workstation outlets to respective equipment rack patch panel outlets shall not be cut or broken and shall be continuous end to end.
2. Copper wire extending from telephone/voice workstation outlets to respective terminal blocks shall not be cut or broken and shall be continuous end to end.
3. Continuity of cable shields (where occurs), polarity and color coding shall be maintained across all splices.
4. Copper wire splices shall be performed to maintain the data transmission rates specified for the entire respective system.

3.6 CABLE TERMINATIONS

A. General

1. Infrastructure workstation outlets connecting to ports in patch panels [and terminal blocks] shall be grouped together in the patch panel [and terminal block] by outlet function, room location and building area location (i.e. Group #l Room #120 1st floor; Group #2 Room #200 east wing, etc.). Each group shall be identified with engraved (etched) nameplates indicating grouping identification and individual port numbers.
2. Polarity and color coding of cable connections at splices, terminations and outlets shall be consistently maintained throughout the entire electronic network system.
3. Terminate all cables onto respective outlets connectors, interconnection couplers and terminals. Terminations shall comply with Manufacturer's recommendations; ANSI/TIA/EIA-568C related Standards, Amendments and TSB.
4. Fiber optic cable fiber strands and copper wire cable conductors terminated at outlet locations shall be connected with a strain relief device attached to the cable jacket to prevent cable tension from being transmitted to the termination connectors.
5. Cable terminations shall be performed to maintain the data transmission rates specified for respective entire system.

B. Fiber Optic Terminations

1. Individual fiber optic fibers shall each be terminated with a fiber optic fiber connector. The connector for each fiber shall be "plugged" into separate fiber optic fiber interconnection couplers on the rear of each respective outlet.
2. Each fiber optic termination ferrule shall be inspected, after completion of the termination, visually with a fiber optic inspection microscope and an interferometer, to insure fiber “undercut”, “protruding” fiber, over polish and under polish of fiber termination ends does not exist in the finished termination ferrule.
3. Fiber optic cables terminated between two fiber optic patch panels located in separate equipment racks. The fibers shall be paired together (Duplex-Pair) for purposes of identification and connection transmit/ receive pair. Each pair of connectors for fibers shall be "plugged" into separate, physically adjacent fiber optic fiber duplex-pair interconnection couplers at each patch panel. The horizontal/vertical arrangement of paired patch panel fiber couplers shall match at both ends of the fiber cable.
4. Fiber optic cable fiber strands terminated at patch panels shall be installed with a minimum of 540 degrees of each fiber strand looped around the splice tray individual fiber ”training” rings.
5. Fiber optic cable connecting from infrastructure workstation outlet to a fiber optic patch panel.
   a. The connectors for fibers shall be "plugged" into separate, physically adjacent fiber optic fiber interconnection couplers.
   b. The patch panel coupler shall be color coded to identify the polarity of the transmitting and receiving optical fibers.
6. Fiber optic cable connections at workstation outlets.
   a. The connectors for fibers shall be "plugged" into separate physically adjacent fiber optic fiber interconnection couplers in the outlet.

C. Copper Wire Terminations

1. Where occurs, the shield on metal shielded copper wire shall be terminated and connected to the shield grounding connection at each termination point.

2. Twisted wire pairs shall not be untwisted for a length of more than 0.4-inch at any location and the cable jacket shall not be striped back not more than 0.5 inch any location including splices and terminations.
3. Unless specifically directed otherwise by the Owner's Representative, Pin assignment for wiring terminations shall comply with ANSI/TIA/EIA-568C type T568A or Type T568B as required for compatibility with the electronic network equipment. The termination type shall be consistent throughout the project Contract area.
4. Copper wire termination's shall be performed to maintain the transmission rates specified for the respective entire system.

3.7 EQUIPMENT RACKS

A. General

1. Install, assemble, mount and connect devices and equipment in the respective equipment racks, bolted securely to the rack frame with stainless steel hardware. "Star" style lock washers shall be provided to insure an electrically continuous ground path between the equipment/devices and rack frames.
2. Provide blank metal filler panels to close unused equipment "front" mounting space in equipment racks, Manufacturer's standard finish color.
3. Provide a copper wire outlet connector in the respective equipment rack for each remote copper wire infrastructure workstation outlet and copper wire cable shown connected to the respective equipment rack, plus the spare copper wire outlet connectors required in the Contract Documents. The copper wire outlet connectors in the equipment racks shall be provided in equipment rack mounted copper wire patch panels. In no case shall the quantity of equipment rack mounted copper wire outlet connectors be less than the quantity of cables indicated on the Drawings, plus required spaces/spares.
4. Provide fiber optic fiber connectors and fiber optic fiber interconnection couplers in the respective equipment rack for each remote fiber optic infrastructure workstation outlet, and fiber optics cable fiber shown connected to the respective equipment rack, plus the spare fiber optic fiber connectors required in the Contract Documents. The fiber optic fiber connectors and fiber optic fiber interconnection couplers in the equipment racks shall be provided in equipment rack mounted fiber optic fiber distribution enclosures (RTDE). In no case shall the quantity of equipment rack mounted fiber optic fiber connectors and fiber optic fiber interconnection couplers be less than the quantity of cables indicated on the Drawings, plus required spaces /spares.
5. Fiber optics cable fibers specifically shown as non-terminated "splicing-thru" in the equipment rack shall route through fiber optic splice only enclosures (RMSE), mounted in the respective equipment rack.
6. The maximum quantity of cable terminations, in each equipment rack mounted patch panels shall not exceed the following. To insure not less than 50% of the rack space remains available for equipment installation:
    a. 100% copper wire outlet connectors, 196 maximum per rack.
    b. 100% fiber optic fiber terminations, 144 maximum per rack.
    c. Combination of copper wire outlet connectors and fiber optic fiber terminations in the same rack; 48 maximum fiber optic fibers plus 144 maximum copper wire outlet connectors per rack. 18 maximum fiber plus 48 maximum copper wire in 30 inches high.
    d. In addition to the quantity of patch panel outlets for termination of incoming and outgoing cables, provide not less than an additional 15% of patch panel spare outlets of each type, in each equipment rack for future use.
7. Provide additional equipment racks, quantity of racks to ensure the maximum specified quantity of terminations in single rack are not exceeded and the quantity of cable terminations complies with the requirements of the Contract Documents.
8. Terminal racks, equipment locations, patch panels, and cross connects shall be arranged to allow for natural cabling progression, minimize crossing of cables and allow easy access to each system component.
9. Equipment Rack Anchorage:
    a. Equipment racks installed on raised "access floor" systems, shall be supported and anchored with bolts that extend into the "structural" floor located below the "access floor".
    b. Securely anchor the support arms of swing gate racks to the wall structural support system.

c. Securely anchor fixed support base of the racks to the floor.
d. Mounting method shall support the total rack weight including installed equipment, but in no case less than 500 pounds with a 2.0 times safety factor.
e. Attachments and anchorages shall comply with the requirements for earthquake seismic rating at the install location.

10. Unless specifically noted, otherwise provide the following equipment rack types:
    a. Floor standing equipment racks containing patch panel locations, computer/data network HUBS/switches and computer data network concentrators, shall be Swing Gate style equipment racks.
    b. Floor standing equipment racks containing multimedia, audio/video, TV head end equipment, shall be Metal Enclosed equipment racks.
    c. Wall mounted external to dedicated IDF/MDF terminal rooms/closets (i.e. inside individual classrooms), shall be Mini-Equipment racks.
11. Install ground bus, PDU/TVSS, cable management rings, equipment, patch panel and patch panel outlets, etc. in equipment racks.
12. Equipment rack terminology:
    a. The location containing the main campus equipment rack location shall be identified as the Main Distribution Frame – (MDF).
    b. The locations remote from the MDF containing satellite equipment racks shall be identified as Intermediate Distribution Frames (IDF).
    c. A individual building located on a multi-building campus site with multiple equipment rack locations in the building, the building main rack location shall be identified as Sub-MDF (or building MDF) and the remaining equipment rack locations in the building shall be identified as IDF.

B. Swing Gate Racks

1. Position the swing gate rack frame to provide a minimum of 30-inches clear space behind the moveable swing gate, for deep recess rack mounted equipment enclosure clearance. 42-inches in front of each rack to allow space for swing-gate 90-degree open position and still allow personnel passage way with the swing gate open. Not closer than 30-inches from rack frame to side-adjacent walls, to allow rack to swing full open with installed equipment.
2. All incoming cables shall enter from the back of the rack. The cables shall cross the hinge side of the rack with sufficient cable slack to allow opening and closing of the swing gate.
3. Provide unobstructed open-close operation clearances of the moveable swing gate. Do not install the edge of the rack closer than 30 inches to an intersecting perpendicular surface or wall.
4. The bottom of the moveable swing gate frame shall be approximately 6-inches above the finish floor.
5. Multiple swing gate equipment racks installed adjacent to each other along a common backboard/wall shall be spaced not less than 44-inches center line to center line and to insure the rack-gate can swing open a full 90-degree Arc with 24-inches deep rack mount equipment enclosures. Adjacent equipment rack with side-by-side hinges on the same side of the rack (left-right) may reduce the edge-to-edge rack side by side spacing to 6-inches for the respective combined two rack location.
6. The fixed non-moving bottom of the rack shall be securely anchored to floor.

C. Floor Standing Equipment Racks

1. General:
    a. Securely anchor racks to floor.
    b. All incoming cables shall enter through the top or bottom of the racks.
    c. The front of the racks shall maintain a minimum of 42-inches of clear working space.
    d. Multiple floor standing racks shall be installed directly adjacent to each other (i.e. side by side), with not less than 6-inches (edge-to-edge) space between adjacent racks.
    e. Cables entering racks shall enter into the top of the rack from overhead cable tray, or from wall along wall support arms to rack.
2. Floor standing metal enclosed equipment racks:
    a. The rear of the rack shall maintain a minimum of 36 inches clear working space.
    b. Provide a minimum spacing between adjacent (edge-to-edge) racks of not less than 6-inches.

3. Floor standing open (non-swing gate) equipment racks.
    a. The rear of the rack shall maintain a minimum of 54-inches clear working space behind the rack frame rails for adequate installation depth of HUBS/ switches equipment, for "walk" behind access to equipment and for cable terminations access.
    b. Provide a minimum spacing between (edge-to-edge) racks of not less than 6-inches.
4. Floor standing modular frame equipment racks:
    a. The rear of the racks shall abut against the wall, or as shown on the Drawing.

3.8 TELEPHONE/VOICE TERMINAL BLOCKS

A. The telephone/voice terminal blocks shall be assembled in vertical sections, for wall mounting. Install adjacent vertical sections with not less than 8-inch blank space between sections, for cable training space.

B. Install terminal blocks on plywood terminal backboard with #8 x 1-inch wood screws. Minimum 6-inches on center, along each side of each terminal block.

C. Terminal block wire pair capacity:
1. The minimum wire termination capacity shall not be less than 600 pairs of telephone/voice conductors, at any telephone/voice terminal block.
2. The quantity of wire pair terminations provided at each terminal block shall be based on the following formula. However, under no case shall any terminal block wire pair capacity be less than the specified minimum.
    Total quantity of telephone/voice feeder copper wire pairs connected to the terminal board = QFP
    Total quantity of telephone/voice outlets connected to terminal board - QTO
    (QFP) x (QTO x 4) + (specified spares) = Minimum terminal block pair capacity.

3.9 MDF AND IDF CIRCUIT TERMINAL ROOMS AND CLOSETS

A. Terminal Backboard
1. A ¾-inch thick marine "A-C" grade plywood backboard shall fully cover each wall of terminal closets and terminal rooms, including all MDF and IDF rooms/closets. Provide backboard on the wall for equipment racks, incoming cable raceways and terminal blocks. Plywood shall extend continuous from the finish floor to 8-feet above the finish floor on all walls. "A" side of plywood shall be exposed.
2. Attach plywood to wall structural framing with mechanical fasteners a minimum 6-inches on center vertically on walls at each framing vertical member, and along the length of the wall, but not less than 16 inches on center horizontally along the length of the wall.
3. Paint plywood terminal backboards after installation and prior to mounting any equipment. One coat of wood paint fire resistant primer and two coats of fire resistant/intumescent, non-conductive finish coats of paint. Finish color matt/flat white, acrylic enamel fire resistant/retardant latex paint.

B. Cable Tray
1. Locations with equipment racks, and/or terminal blocks are installed in the same room/closet (MDF or IDF).
    a. Provide a horizontal cable tray above the equipment racks and terminal blocks in each circuit terminal room and closet.
    b. Provide a horizontal cable tray continuous “loop” around the perimeter inside each MDF and IDF room, within 12-inches of the ceiling. Parallel with and adjacent to all walls in the room.
2. Ladder type cable tray 18 inches wide by 6 inches deep; length-end wall to end wall, of the closet or room.
3. Install the cable tray centered above all equipment racks, and around the room perimeter at ceiling/walls [and terminal blocks] with ceiling and wall suspension system. Install trays not more than 36-inches above and not less than 12-inches above the top of the equipment racks.
4. Where multiple segments of cable trays occur in terminal closets and rooms, provide interconnecting cable trays between each segment located in the respective room/closet.

C. Conductor Training and Support

1. Provide conductor/cable training and racking support distribution rings installed on backboards. As manufactured by Newton 3042 series, Saunders or equal.
2. Support rings shall be spaced a minimum of 10-inches on center along all cable/conductor routing paths on backboards and within 4-inches of each change in cable/conductor direction.
3. The capacity of support rings shall be equal to the weight and quantity of conductors/cables passing through the respective support ring plus 100% spare capacity for installation future conductors/cables. In no case shall support rings be smaller than 3 inches.
4. Attach support rings to backboards with not less than two 3/8-inch diameter by 1⅛-inch long threaded wood anchor bolts for each individual bracket.

D. Environment Space Monitoring (MDF and IDF)

1. In each room/closet provide one automatic environmental monitor. Self-calibrating, simultaneous monitoring and software programmable, with alarm set points. Shall measure and monitor ambient conditions and provide data-logging for conditions in the space for the following:
   a. One ambient temperature port and plug-in indoor sensor.
   b. One ambient humidity port and plug-in indoor sensor.
   c. One spare plug-in port for an external digital sensor.
2. Digital Fast Ethernet LAN RJ-45 communications port, with alarm alerting and communications software for remote monitoring of the ambient conditions via the LAN. Multi-user site wide software license, compatible with PC-computer and IP-WEB HTTP remote operations.
3. Local internal audio and visual alert annunciators, with local silence and reset.
4. 120 volt, 60Hz AC input power supply operation. Equipment rack mount self-contained unit housing configuration. Provide all interconnect cabling and connectors.
5. Provide the environmental unit in one of the equipment racks located in each of the respective spaces.
6. As manufactured by Avtech-Room Alert; or SensaTronic-Evironmental Systems; or IT Watch Dog-Climate Monitors.

3.10 GROUND (ADDITIONAL REQUIREMENTS)

A. Electronic Equipment MDF, IDF and Terminal Rooms and Closets

1. Terminal Equipment Ground Bus (TEGB) - Provide a wall mounted TEGB ground bus in each MDF location. Also provide a TEGB where two or more equipment racks and/or terminal blocks are provided in each IDF. The TEGB ground bus shall be copper ¼-inch by 2-inches (nominal) by 12-inches long (minimum). Install the TEGB on the wall with a minimum of two "stand-off" electrical insulators. Drill and tap the ground bus and provide bolted type ground lugs for connection of each ground conductors size #10AWG - #1AWG. Provide spare unused ground lugs on the TEGB.
2. Provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB homerun to the building main ground reference bus. Provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB homerun to the nearest building main structural steel member and to the nearest metal cold water pipe larger than 0.6-inch diameter pipe.
   a. Provide the same ground connections from the equipment rack ground bus where only a single equipment rack occurs in the IDF location.
3. The ground conductor required from the TEGB to the building main ground reference bus may be looped and connected between separate TEGB ground bus locations if all of the following conditions are met.
   a. The ground conductor is increased to 1.5-inch conduit with 1#2/0AWG copper insulated and the total end to end length does not exceed 300-feet.
   b. The building exceeds two floors in height.
   c. Not more than four TEGB buses are connected to the same "looped" ground conductor.
   d. The TEGB ground conductor is continuous (not cut, spliced or broken) along its entire length.
   e. The TEGB ground conductor is connected to the TEGB ground buses with a UL listed "Exothermic" welding process.

B. Equipment Racks:
   1. Provide a separate 12AWG copper stranded green insulated ground conductor from each individual equipment element in the rack to the respective rack ground bus.
   2. Provide a separate #8AWG copper insulated ground conductor from each equipment rack ground bus to the TEGB terminal equipment ground bus located in the same space.
   3. Where only one equipment rack is installed, provide 1.25-inch conduit with 1#1AWG copper insulated ground homerun conductor from the equipment rack ground bus homerun to the building main ground reference bus and provide 1.25-inch conduit with 1#1AWG copper insulated ground conductor from the TEGB or single equipment rack ground bus (as applicable), to the nearest building main structural steel member and to the nearest metal cold water pipe larger than 0.6-inch diameter pipe.
   4. Provide 1.25-inch conduit with 1#4AWG copper insulated ground conductor from each wall mounted fiber interface cabinet to the respective TEGB ground buses.
   5. Provide a 1#10AWG copper insulated ground conductor connecting in a continuous loop to all miscellaneous cable trays and metal support equipment located in the terminal closet or room and connect to the TEGB ground bus.

C. Telephone/Voice Terminal Blocks:
   1. Provide a separate #8 copper insulated ground conductor from each terminal block section ground bus to the TEGB terminal equipment ground bus.
   2. Provide a separate #6 copper insulated ground conductor from the terminal room/closet to the lightning ground system.

3.11 WALL MOUNTED FIBER INTERFACE CABINET - WMIC

3.12 IDENTIFICATION (ADDITIONAL REQUIREMENTS)

A. General
   1. Fiber optic and copper wire cables shall be identified in each manhole, pull box, equipment rack, patch panel and computer workstation outlets.
   2. Infrastructure documentation, identification labels and color coding shall comply with ANSI/TIA/EIA-606A Administration Standard for Telecommunications Infrastructures, Class-1 thru Class-4. Provide management software MS-Windows-based single user license, with all as-built data entry documentation information complete.

B. Identification tags shall include the following information:
   1. Cable name as indicated on Drawings (i.e., HV1, F4, MSB3 etc.).
   2. Installation month and date (i.e., 3/92, 4/78 etc.).
   3. Conductor size conductor type (i.e., loose tube fiber; #24AWG ScTP Category 5, 200-pair, telephone/voice etc.).
   4. Feeder taps to equipment or building shall also be identified with equipment name or building (i.e. library, SW1, Rack #21, etc.)

C. Identification Tags
   1. Tags shall be ⅛-inch thick 98% lead, approximately 2-inch square with chamfered corners. Two holes shall be drilled for attachment to primary cable. Lettering shall be ⅛-inch high, engraved or die stamped. Attach tags to primary cables with two #14AWG (THWN insulated) solid copper conductors "twist-tied", with insulated CAP wire-nut on the tie-wire ends, to cover sharp edges of tie-wire conductor.
   2. Alternate identification tags, at the Contractor’s option in lieu of lead tags. Provide polypropylene tag holders with interchangeable, yellow polypropylene tag with black alphanumeric characters sets. Characters shall be approximately .25-inch high. As manufactured by Almetek industries "EZTAG" - Ledgewood, New Jersey.

D. Equipment and outlet naming identification and color-coding shall comply with ANSI/EIA/TIA latest revision.

1. Naming method for equipment, outlets and cables; where a position in the naming string is unused, provide multiple "****" symbols.
   Typical naming string "ADM-02-1141-PP17-1271"
   a. "ADM" - Abbreviated Building Name or Number (i.e., Administration, B127, etc.)
   b. "02" - Floor Level #2 or as applicable.
   c. "1141" - Outlet, Equipment or Terminal Room/Closet name or room number as applicable.
   d. "PP17" - Terminal Rack Patch Panel Identification.
   e. "1271" - Individual Outlet or Port Identification.
2. Connecting hardware color coding shall be as follows:
   "Green" - Main central terminal location for entire site.
   "White" - Distributed terminal locations other than the main terminal.
   "Blue" - Horizontal wiring hardware systems for workstations.

E. Provide warning nameplates on fiber optic patch panels, fiber optic outlets, and any location where fiber optic cables are terminated. Minimum ⅛-inch high engraved/ etched letters. "WARNING - LASER LIGHT SOURCE. DO NOT LOOK DIRECTLY AT OUTLET OR FIBER CABLE ENDS. RISK OF SEVERE EYE DAMAGE OR BLINDNESS".

END OF SECTION 272000
062117/1010006

SECTION 273226
EMERGENCY PHONES

PART 1 GENERAL

1.1 DESCRIPTION

A. This section includes the requirements for provision and installation of the intercom system. Provide a complete and functioning two-way communication system for the Santa Ana College STEM (SAC) Project.

B. Contractor shall furnish and install hardware devices, stanchions, and other components of the system as shown and specified.

C. Furnish and install outlets, junction boxes, conduit, connectors, wiring, and other accessories necessary to complete the system installation. Requirements shall be in accordance with Division 26, Electrical.

1.2 PRECEDENCE

A. Obtain, read and comply with General Conditions and applicable sub-sections of the contract specifications. Where a discrepancy may exist between any applicable sub-section and directions as contained herein, this section shall govern.

1.3 GENERAL CONDITIONS

A. In accordance with Section 28 05 00, Security System General Requirements

1.4 RELATED WORK

A. In accordance with Section 28 05 00, Security System General Requirements

B. In accordance with Section 28 07 00, Security System Integration

C. In accordance with Section 28 08 00, Security System Testing and Commissioning

1.5 APPLICABLE PUBLICATIONS

A. In accordance with Section 28 05 00, Security System General Requirements

1.6 SHOP DRAWINGS & EQUIPMENT SUBMITTAL

A. In accordance with Section 28 05 00, Security System General Requirements

1.7 OPERATING AND MAINTENANCE MANUALS

A. In accordance with Section 28 05 00, Security System General Requirements.

1.8 SERVICE AND MAINTENANCE

A. In accordance with Section 28 05 00, Security System General Requirements

1.9 TRAINING

A. In accordance with Section 28 05 00, Security System General Requirements

1.10 WARRANTY

A. In accordance with Section 28 05 00, Security System General Requirements

1.11 TECHNICAL REQUIREMENTS, EMERGENCY PHONE SYSTEM

A. General

1. The following information is provided to establish required system performance for a complete operating Emergency Phone System for the site. Some functions and performance requirements noted herein are supported and supplied by existing systems in concert with new equipment which shall be provided by the Contractor under this scope of work. Contractor shall provide equipment, wiring and programming at all sites as necessary to provide a complete system as described herein and as shown on the drawings.
2. Components provided under this scope of work shall be compatible with the SAC communications phone system. Coordinate with the Owner on the necessary provisions.
3. SAC will provide network connectivity and phone system interfaces from the site connection point. Contractor shall be responsible for providing equipment and connections at the site to achieve specified system performance when connected to the SAC phone system.

B. Purpose: The system is designed to allow communications from the device to the programmed responding location allowing the responder to assist the caller.
   1. Attributes
      a. General
         1) Exterior Emergency phones with visual locating devices are located in public areas outside the buildings as shown on plans.
      b. Exterior Emergency Phones
         1) Emergency phones utilize the campus phone system dialing automatically to call a monitoring location.
         2) Each device shall be equipped with a blue light identifying the location of activation.
         3) Each device shall be equipped with a single pushbutton which will activate the calling function and the blue location light.
         4) Emergency phone shall be provided in a wall mounted or free standing configuration, as indicated on the plans.
         5) Emergency Phones shall be integrated within the existing SAC EACS and VSS System

PART 2 PRODUCTS

2.1 GENERAL

A. Product Acceptability: The Products section contains lists of acceptable products. If product substitutions are proposed, they must be made based upon a comparison of equivalence to the product specified and compatible with the existing SAC system. Considerations may include but shall not be limited to functional, physical, aesthetic and/or interface aspects. The Owner shall be the sole judge of whether or not a submitted substitution is deemed to be equivalent" to that specified. Contractor may not use contractor proprietary interface modules for connections between field devices and controller

B. Equipment shall have a UL Listed mark on the product.

C. Assemblies shall be approved by a recognized agency acceptable to the City of Los Angeles.

2.2 EMERGENCY PHONE

A. Provide Emergency Phones in the following configurations. Phones shall incorporate communication compatible with the Owner’s communications system.
   1. Tower Phone

a. Provide “Talk-A–Phone” model ETP-MT/R Phone Tower, with the following characteristics.
   1) Vandal-resistant, exterior enclosure
   2) Blue Strobe Light housed in protective acrylic housing that is activated when the call button is pressed
   3) Constant light Faceplate
   4) Power: 120VAC
   5) Provide color as required by Owner
   6) Shall meet ADA requirements for access
   7) UL listed
b. Provide ETP-400 series single button faceplate with Red Emergency activation button
   1) Lettering “EMERGENCY”
   2) LED indicator for hearing impaired
   3) Built in auto-dialer
   4) Auto-Answer
   5) Second number dial on first number no answer
   6) Unit shall be hands-free after activation
   7) Stainless Steel faceplate
   8) Shall include speaker for audible communication
   9) Shall include activation button.

2.3 WIRE AND CABLE

A. General: Cables which are not installed in conduit shall be a version of the specified cable rated for use in plenums.

B. System cable: Provide cable as shown below, or as recommended by the Manufacturer.
   1. Emergency Phone: Belden 5302GE, 1 Pair Twisted Shielded 18AWG, with 2 conductor 18AWG, or equal.
   2. Alarm Monitoring: Belden 5500FE, 1Pair Shielded 22AWG, or equal, for connection to EACS.
   3. Network Cable: As required by Owner Infrastructure. Refer to the drawings

C. Cable installed below grade shall be rated for immersion in water.

PART 3 EXECUTION

3.1 GENERAL

A. In accordance with Section 28 05 00, Security System General Requirements.

3.2 EMERGENCY PHONE INTEGRATION

A. Provide access control system integration equipment, software programming, in accordance with Section 28 07 00, Security System Integration. In addition provide specific integration schemes noted.

3.3 GROUNDING PROCEDURES

A. Provide grounding of all systems and equipment in accordance with Section 28 05 00, Security System General Requirements.

3.4 WIRE AND CABLE INSTALLATION PRACTICES

A. Provide wire and cable installation in accordance with Section 28 05 00, Security System General Requirements.

3.5 START-UP RESPONSIBILITY

A. Provide start-up services for all systems and equipment in accordance with Security System General Requirements, Section 28 05 00.

3.6 PRELIMINARY INSPECTION AND TESTING

A. Provide preliminary inspection and testing services for systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

3.7 SYSTEM PERFORMANCE TESTING AND ADJUSTING PROCEDURES

A. Provide performance testing and adjusting of systems and equipment in accordance with Testing and Commissioning, Section 28 08 00.

B. Emergency Phone

1. Verify phone indicator is on
2. Verify phone indicator flashes when activated.
3. Verify voice communication with called station
4. Verify visual indicator is on during normal operation
5. Verify visual indicator strobe function is activated during use.

3.8 BURN-IN PERFORMANCE PERIOD

A. Provide a burn-in performance period to demonstrate the stability of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.9 COMMISSIONING AND VALIDATION

A. Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with Testing and Commissioning, Section 28 08 00.

3.10 TRAINING

A. Provide training requirements of Security System General Requirements Section 28 05 00

3.11 FINAL PROCEDURES

A. Perform final procedures in accordance with section 28 05 00, Security System General Requirements.

END OF SECTION

SECTION 274116

INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Provisions of Division 1 apply to this section.

B. Section Includes
   1. Provide all labor, materials, transportation and equipment to complete the furnishing, installation, assembly, set up, and testing of the Audio, Video and Control Systems work indicated on the drawings and specified herein. Notwithstanding any detailed information in this Section, provide complete, working systems. General design intent for this project is shown on the drawings and described in the specification.
   2. All equipment requiring coordination with other trades must be tested and verified for proper operation. Contractor is fully responsible for the coordination and must resolve all conflicts with AV equipment that connect or interact with other systems.
   3. Design, engineer and provide complete means of support, suspension, attachment, fastening, bracing, and seismic restraints (hereinafter "support") of the Work of this Section, including future installed equipment, in accordance with local building codes and regulations. Provide engineering of such support by parties licensed to perform work of this type in the Project jurisdiction. Contractor shall obtain the services of an engineer licensed to perform this work within the state or jurisdiction it is to be performed.
   4. The Contractor shall include all costs associated with structural engineering required by code for work in this section.
   5. Use skilled mechanics that are capable of returning surfaces to the appearance of new work when modifying millwork.
   6. Conduit and common back boxes including four square, pull boxes, junction boxes, etc. are supplied and installed by Division 26 Electrical Contractor. Connection panels that install in these boxes are supplied by AV Contractor.
   7. Provide Power Over Ethernet switches and injectors where required.
   8. Provide all cable and wire associated with this specification section and related documents.
   9. All systems shall be completely installed with all of the necessary interconnection, power supplies, patch cords, snakes, portable equipment cables and wiring to provide a fully functioning system.
   10. The governing overall requirement for this project is a complete and functional system.
   11. Include work not usually shown or specified, but necessary for proper installation and operation of the system or piece of equipment.

C. Products Supplied But Not Installed Under This Section
   1. Loose equipment or products supplied but not installed shall be turned-over to the Owner immediately upon delivery. Contractor is to supply a signed statement of transfer of this equipment to the consultant for record. Client must sign this statement acknowledging receipt of this equipment.
   2. Specialty floor boxes, back boxes including but not limited to Crestron, AMX, Extron, FSR, Steel City and speaker back boxes shall be provided to the General Contractor for installation.

D. Products Installed But Not Supplied Under This Section
   1. Owner Furnished and existing equipment as shown on drawings.

E. Related Sections
   1. 019113 – General Commissioning Requirements
   2. Division 9.
   3. Division 10.

4. Division 11.
5. Division 26.

F. Measurement Procedures
1. Product quantity is as required. If a quantity is given, the Contractor will provide at least the given amount. Some products listed under this section may not be required to fulfill the obligations of the work.

1.2 REFERENCES

A. Comply with all applicable governing codes.

B. Comply with the following applicable organizations and standards:
1. AES Audio Engineering Society
2. ANSI American National Standards Institute
3. ASTM American Society for Testing and Materials
4. BICSI Building Industry Consulting Service International, Inc.
5. BTSC Broadcast Television Stereo Committee
6. CEDIA Custom Electronic Design and Installation Association
7. EIA Electronic Industries Alliance
   a. RS-310-C: (ANSI C83.9) Racks, Panels, and Associated Equipment
   b. RS-453: Dimensional, Mechanical, and Electrical Characteristics Defining Phone Plugs and Jacks
8. ETL Electrical Testing Laboratories, Inc.
9. FCC Federal Communications Commission
10. ICIA International Communications Industries Association
11. IEC International Electrotechnical Commission
12. IEEE Institute of Electrical and Electronic Engineers
13. INCITS InterNational Committee for Information Technology Standards
14. ISO International Organization for Standardization
15. ITU International Telecommunications Union
16. NAB National Association of Broadcasters
17. NCTA National Cable and Telecommunications Association
18. NEC National Electrical Code
19. NEMA National Electrical Manufacturers Association
20. NFPA National Fire Protection Association
21. NSCA National Systems Contractors Association
22. OSHA Occupational Safety and Health Administration
23. SMPTE Society of Motion Picture and Television Engineers
24. TASO Television Allocation Study Organization
25. TIA Telecommunications Industry Association
26. UBC Uniform Building Code
27. UL Underwriters Laboratories Inc.

1.3 DEFINITIONS

A. Definitions of Terms: The following definitions and conditions apply to each of the respective parameters and the measurements of those parameters, unless specifically stated otherwise:
1. Frequency Response: The minimum acceptable frequency band over which the amplitude response is within 3 dB (or any specified range), or the specified limits of the response relative to the reference frequency (1 kHz for audio, 1.0 MHz for video) under design load conditions, at any operating level up to and including the specified maximum output while fully in compliance with all other performance specifications.
2. Maximum Output Level: The minimum acceptable maximum signal output level (voltage, current or power) attained under design load conditions attained while fully in compliance with all other performance specifications.

3. Harmonic Distortion: The maximum acceptable harmonic distortion measured at any operating level, up to and including the specified maximum output, with an applied sine wave signal of any frequency in the range of the specified frequency response.
4. Audio Intermodulation Distortion: The maximum acceptable intermodulation distortion resulting from the introduction of 60 Hz and 7 kHz signals in a ratio of 4:1 under design load conditions at any operating level up to and including the specified maximum output level.
5. Signal to Noise Ratio: The minimum acceptable ratio of signal to noise levels derived from broadband measurements under design load at maximum output over the entire range of the specified frequency response.
6. Clipping Level: The minimum acceptable maximum level of signal applied to the device under design load conditions while fully in compliance with all other performance specifications.
7. Sensitivity: The maximum acceptable level of input signal applied to the device that is necessary to provide the maximum output under design load conditions.
8. Design Load: The load (in ohms) specified by usage of the particular device input or output.

B. Signal Levels: The following voltage levels shall be considered the standard operating levels for the particular circuitry, unless specifically noted otherwise (0.775 Volt = O dBu = O dBm for a 600 ohms terminated circuit):
1. Microphone Circuits: -30 dBu or less.
2. Audio Line Level Circuits: -30 dBu to +24 dBu; equivalent to -30 dBm to +24 dBm for a 600 ohms terminated circuit.
3. Loudspeaker Level Circuits: More than +24 dBu.
4. Video Line Level Circuits: 1.0 Volt, peak to peak composite signal.

C. Characteristic Impedances: The following operating impedances shall be considered to be the standard operating impedances for the particular circuitry, unless specifically noted otherwise:
1. Microphone Circuits: 50-250 ohms source, 150-1500 ohms terminating, electrostatically and electromagnetically balanced to ground.
2. Audio Line Level Circuits: 600 ohms maximum source, 600 ohms minimum. terminating, line to line, electrostatically and electromagnetically balanced to ground.
3. Video Line Level Circuits: 75 ohms maximum source, 75 ohms minimum terminating to shield and signal ground, with Vertical Standing Wave Ratio (VSWR) not to exceed 1.2.

1.4 SYSTEM DESCRIPTION

A. Design Requirements
1. General
a. The Santa Ana Science Center audio-visual system includes Classrooms, Labs, a Conference Room, Science Learning Center, Digital Signage displays.
b. An Owner Furnished, Owner Installed (OFOI) integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, lighting, shades and audio levels. The control system shall be by Utelogy Corporation.

B. Classroom, Lecture, Computer Lab – 900 SF to 1200 SF; Single Projector
1. General
a. The room shall be provided with a presentation system adequate for the display of high resolution computer graphics and pre-recorded audio-video media.
b. The system shall provide speech reinforcement (including ADA compliant assistive listening devices) features.
c. The projection system shall allow for interactive collaboration. Features include the ability to annotate images, save and share it.
d. An Owner Furnished, Contractor Installed (OFCI) lectern shall be provided to house an equipment rack with source and switching equipment.
e. A digital video presentation system switcher shall be used for control and matrix switching of audio and video signals.
2. Sound Reinforcement System

a. Ceiling speakers shall be provided for sound reinforcement of voice and program material.
b. Connectivity for a portable wireless microphone system shall be provided at the lectern. The system shall consist of a RF receiver and lavalier microphone to allow for voice reinforcement.

3. Video
   a. A wall mounted ultra-short throw video projector shall be provided to project general video media and computer presentation material onto a whiteboard. The projector shall be capable of at least 400 lux per square meter measured at the screen. The projector shall have a 16:10 aspect ratio capable of WXGA resolution. All relevant aspects of the video projector's operation shall be controlled via the main control system.
   b. A digital video presentation system switcher shall be used to route any source signal to the projector.
   c. An input panel shall be provided in the lectern to allow connection of laptop computer and portable audio-video equipment to the system.
   d. Sources installed in the lectern shall include the following OFCI equipment: document camera, Blu-ray player, PC and monitor,
4. Remote Control Systems
   a. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
   b. A web based User Interface shall be provided to control and monitor all aspects of the AV system. The interface will be programmed to recall system presets.
5. Assistive Listening
   a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

C. Large Classroom – 1575 SF to 1740 SF; Dual Projectors
1. General
   a. The room shall be provided with a presentation system adequate for the display of high resolution computer graphics and pre-recorded audio-video media.
   b. The system shall provide speech reinforcement (including ADA compliant assistive listening devices) features.
   c. The projection system shall allow for interactive collaboration. Features include the ability to annotate images, save and share it.
   d. An OFCI lectern shall be provided to house an equipment rack with source and switching equipment.
   e. A digital video presentation system switcher shall be used for control and matrix switching of audio and video signals.
2. Sound Reinforcement System
   a. Ceiling speakers shall be provided for sound reinforcement of voice and program material.
   b. A lectern mounted gooseneck microphone shall be provided for voice reinforcement of the instructor.
3. Video
   a. Two wall mounted ultra-short throw video projector shall be provided to project general video media and computer presentation material onto a whiteboard. The projector shall be capable of at least 400 lux per square meter measured at the screen. The projector shall have a 16:10 aspect ratio capable of WXGA resolution. All relevant aspects of the video projector's operation shall be controlled via the main control system.
   b. A digital video presentation system switcher shall be used to route any source signal to the projectors.
   c. An input panel shall be provided in the lectern to allow connection of laptop computer and portable audio-video equipment to the system.
   d. Sources installed in the lectern shall include the following OFCI equipment: document camera, Blu-ray player, PC and monitor,

e. In the Anatomy Lab (SC217), a ceiling recessed, PoE, PTZ camera shall be provided for directly above the demonstration table. The camera's signal shall be viewed via the Instructor's PC and routed to the projector as necessary. Camera control shall be per the web base interface as described below.

4. Remote Control Systems
   a. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
   b. A web based User Interface shall be provided to control and monitor all aspects of the AV system. The interface will be programmed to recall system presets.
5. Assistive Listening
   a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

D. Divisible Classroom – 1850 SF
1. General
   a. Each room shall be provided with a presentation system adequate for the display of high resolution computer graphics and pre-recorded audio-video media.
   b. The system shall provide speech reinforcement (including ADA compliant assistive listening devices) features.
   c. The projection system shall allow for interactive collaboration. Features include the ability to annotate images, save and share it.
   d. Each lectern shall be provided to house an equipment rack with source and switching equipment.
   e. Digital video presentation system switchers shall be used for control and matrix switching of audio and video signals.
2. Sound Reinforcement System
   a. Ceiling speakers shall be provided for sound reinforcement of voice and program material.
   b. A lectern mounted gooseneck microphone shall be provided for voice reinforcement of the instructor.
3. Video
   a. A wall mounted ultra-short throw video projector shall be provided in each room to project general video media and computer presentation material onto a whiteboard. The projector shall be capable of at least 400 lux per square meter measured at the screen. The projector shall have a 16:10 aspect ratio capable of WXGA resolution. All relevant aspects of the video projector's operation shall be controlled via the main control system.
   b. A digital video presentation system switcher shall be used to route any source signal to the projectors.
   c. An input panel shall be provided in the lectern to allow connection of laptop computer and portable audio-video equipment to the system.
   d. Sources installed in the lectern shall include the following OFCI equipment: document camera, Blu-ray player, PC and monitor,
4. Remote Control Systems
   a. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
   b. A web based User Interface shall be provided to control and monitor all aspects of the AV system. The interface will be programmed to recall system presets.
5. Assistive Listening
   a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

E. Engineering Lab
1. General

a. The room shall be provided with a presentation system adequate for the display of high resolution computer graphics and pre-recorded audio-video media.
b. The system shall provide speech reinforcement (including ADA compliant assistive listening devices) features.
c. A lectern shall be provided to house an equipment rack with source and switching equipment.
d. A digital video presentation system switcher shall be used for control and matrix switching of audio and video signals.

2. Sound Reinforcement System
   a. Ceiling pendant speakers shall be provided for sound reinforcement of voice and program material.
   b. A lectern mounted gooseneck microphone shall be provided for voice reinforcement of the instructor.
3. Video
   a. A ceiling mounted video projector shall be provided to project general video media and computer presentation material onto a motorized front projection screen. The projector shall be capable of at least 400 lux per square meter measured at the screen. The screen shall have a 16:10 aspect ratio capable of WUXGA resolution. All relevant aspects of the video projector's operation and the projection screen shall be controlled via the main control system.
   b. A digital video presentation system switcher shall be used to route any source signal to the projector.
   c. An input panel shall be provided in the lectern to allow connection of laptop computer and portable audio-video equipment to the system.
   d. Sources installed in the lectern shall include the following OFCI equipment: document camera, Blu-ray player, PC and monitor,
4. Remote Control Systems
   a. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
   b. A web based User Interface shall be provided to control and monitor all aspects of the AV system. The interface will be programmed to recall system presets.
5. Assistive Listening
   a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

F. Conference Room
1. General
   a. The system shall provide support for events such as meetings, teleconferencing and web conferencing.
   b. The system shall provide an ADA compliant assistive listening device features.
2. Video
   a. A wall mounted ultra-short throw video projector shall be provided in each room to project general video media and computer presentation material onto a whiteboard. The projector shall be capable of at least 400 lux per square meter measured at the screen. The projector shall have a 16:10 aspect ratio capable of WXGA resolution. All relevant aspects of the video projector's operation shall be controlled via the main control system.
   b. An input panel shall be provided in the conference table to allow connection of laptop computer and portable audio-video equipment.
   c. HDBaseT transmitters (with HDMI and VGA + audio connections) and receiver shall be provided to transport analog and digital signals from the conference table and credenza to the display.
3. Remote Control Systems
   a. The video display shall be controlled with a wall mounted controller as shown on the plan. The controller shall be capable of turning the display on and off, adjusting the volume, and switching sources.

b. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.

4. Assistive Listening
   a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

G. Science Learning Center
   1. General
      a. The room shall be provided with a presentation system adequate for the display of high resolution computer graphics and pre-recorded audio-video media.
   2. Sound Reinforcement System
      a. Ceiling speakers shall be provided for sound reinforcement of voice and program material.
      b. A lectern mounted gooseneck microphone shall be provided for voice reinforcement of the instructor
   3. Video
      a. A ceiling mounted video projector shall be provided to project general video media and computer presentation material onto a motorized front projection screen. The projector shall be capable of at least 400 lux per square meter measured at the screen. The screen shall have a 16:10 aspect ratio capable of WUXGA resolution. All relevant aspects of the video projector's operation and the projection screen shall be controlled via the wall controller.
      b. An input panel shall be provided near the service desk to allow connection of laptop computer and portable audio-video equipment to the system.
   4. Remote Control Systems
      a. An integrated web enabled central control system will be used to control all aspects of the audio and video system's functions, signal routing, and audio levels.
      b. A web based User Interface shall be provided to control and monitor all aspects of the AV system. The interface will be programmed to recall system presets.
   5. Assistive Listening
      a. Connectivity for a portable Assistive Listening System (ALS) shall be provided per ADA requirements. The system will consist of an RF transmitter and headsets to allow personal monitoring of the audio program.

H. Public Area - Digital Signage Display
   1. General
      a. These areas shall include a wall mounted 48" or 60" LED monitor used as digital signage displays.
      b. The video monitors shall have the ability to display information, including class schedule, current events, way finding and RSS feeds from the existing campus wide digital signage system.
      c. The contractor shall supply and install an owner specified small form factor PC or signage server that is compatible with the existing digital signage system. The PC or server shall be connected to the College's LAN.
      d. The displays and PCs shall include all mounting hardware required for proper installation.

I. Software Programming
   1. General
      a. Except when otherwise agreed in writing the client shall retain legal and beneficial ownership of all Intellectual Property, including source code, created by the Contractor, their employees and sub-contractors.

b. The Contractor must allow sufficient time for the programming of all software configurable audio, video and control systems. Contractors must evaluate the systems functional requirements and user interface and then allow time in their bid accordingly. The system description as well as the end user interview will provide the Contractor with the necessary information needed to proceed with the programming. Any questions as to the systems functional requirements must be sent in written RFI form to the Consultant. All programming schemes must be submitted to the Consultant for approval before programming starts. This includes the appearance of all user interfaces, touch panel layouts, preset and sub-preset information (acquired through client interviews), and speaker control schemes. The Contractor will also submit a narrative for the control system concept to the Consultant for approval. The Contractor is to interview the Owner and their representatives to acquire the necessary information needed to allow for the proper programming of this system. The Contractor, after interviewing the Owner, will then submit a written report stating his interpretation of the client's requirements for approval by Consultant. Only after the Client and Consultant have approved the programming report may the Contractor proceed with the programming of this system.
c. All equipment that is connected to the Client's local area network and is configurable via the local area network must have its equipment software installed onto dedicated computers provided by the Client. The Contractor is to allot time to install and test equipment software onto a minimum of two of the Client's computers which are to be identified by the Client and/or Consultant. The computers will be programmed to emulate user interfaces throughout the facility. The Contractor shall coordinate all software deployment over IP with the Client's Information technology department.

2. Control system minimum programming outlined below:
   a. The Contractor shall allot 4 hours for on-site control system programming with the Client's representative.
   b. The Control System in this project shall connect to the Client's Local Area Network (LAN). This connection will provide desktop computers control of the audio-visual system as well as make available remote troubleshooting via the internet. The Contractor shall provide time to install control system interface software on at least three desktop computers. Coordinate work with Client's Information Services personnel.
   c. Provide password protection to each control surface in this facility. Upon start up a password dialog box shall be presented to the user to enter his/her password. Only after entering a password will the user have access to the system. The system shall be programmed to shut down automatically after being idle for a time to be specified by the user.
   d. Unser Interface layout design will conform to the InfoComm International "Dashboard for Controls" guidelines. Touch panel designs are to be custom to this project. Re-purposed touch panel designs are not acceptable.
   e. Technical users shall have the ability to access individual speaker zone controls via the User Interface.
   f. The contractor shall provide a default audio level preset button, in the control system user interface, to allow a user or technician to recall all gain levels that were set when the system was commissioned.
   g. Control Help File: Each touch panel will include a help file that will explain each layer of the touch-panel control scheme.
   h. Control system shall utilize help desk software to provide:
      1) Real-time monitoring of:
         (a) Control system.
         (b) Device monitoring.
         (c) Projector lamp life.
         (d) System online status.
         (e) Room activity.
      2) Remote system diagnostics via Contractors help desk.
      3) Remote system control.
      4) Event scheduling.

5) Fault reporting via email alert.
6) Logging of help request.
7) User access control via password protection.
8) Event logging, report and chart generation.

i. The help desk software shall be placed on the desktop computers of each audio-visual maintenance person as well as key personnel of the Client. The Contractor shall train maintenance and operations persons to use this software feature.
j. Provide, install and test, room scheduling software programs to allow scheduling of each AV enabled room.
k. All serial controlled devices must have bi-directional communication with the control system. All control functions locally available on each device must be accessible via the remote control system. All locally gestured control functions must mirror on the control system user interface. In other words, if a volume control is adjusted on a DSP interface that adjustment must register on the control interface.
l. Control system shall be used to power up and down connected equipment at control system start up and shut down.
m. Control system shall control both lighting and motorized window shades in each room. Provide adequate presets to allow training and video conferences as explained in room descriptions above.
n. The control system shall monitor the connected power amplifiers and report overheating that may occur.
o. All projectors shall be monitored and report lamp hours remaining and lamp failure.

3. Complexity of Programming:
   a. It is required that the Contractor be experienced in programming systems of this complexity. Contractors shall allow enough time in their bid to permit extensive programming of all software configurable audio, video and control systems to the requirements of the client and consultant. Contractor shall break out cost associated with programming of these systems for review by the Consultant. By submitting this bid, the Contractor agrees that they understand systems of this type and that all programming services are included to the satisfaction of the Consultant. The Contractor further agrees that they will not make any claim for additional monies because of misinterpretation of programming requirements.

J. System Performance Standards and Requirements (meet or exceed)
   1. Audio Systems:
      a. Electrical Performance; Source Input to Power Amplifier Output:
         1) Frequency Response (Equalizer flat): +/- 0.2 dB 20 Hz to 20 kHz.
         2) Total Harmonic Distortion (THD): Less than 0.05%, 20 Hz to 20 kHz, 4 ohms.
         3) Noise: At least -105 dB, 20 Hz to 20 kHz, referenced to input of +4 dBm.
         4) Crosstalk: At least -60 dB, 20 Hz to 20 kHz.
         5) Damping Factor: Greater than 500 (below 1 kHz)
      b. Electro/Acoustic Performance; Distributed Systems: 103 dB Consistent with devices specified herein.
         1) Equipment: Specified individually.
         2) Audio signal paths: Shall not degrade performance of connected equipment.
      c. NEC - Article 640: Audio Signal Processing, Amplification and Reproduction Equipment.
   2. Video Systems:
      a. Video signal system: NTSC to EIA RS-170A, except as noted.
      b. Video signal paths: To EIA RS-250C short haul where equalized or fiber optic transmission, otherwise to the performance limit of the specified video cable.
      c. ANSI IT7.228 (ANSI Lumens): Measurement method for light output of fixed resolution video projection systems.
      d. ANSI IT7.228 (ANSI Contrast Ratio): Measurement method for the contrast ratio of fixed resolution video projection systems.
      e. SMPTE 170M: Color Specification for NTSC.

f. SMPTE 125M: Universal Sampling spec for SDTV and HDTV Broadcast Video.
g. SMPTE 253M: RGB Analog Video Interface spec for SDTV Studio applications.
h. SMPTE 274M: Component spec for 1920 x 1080 HDTV.
i. SMPTE 296M: Spec for 1280 x 720 RGB and YPbPr Baseband Video.
j.

3. Data and Communications Systems:
   a. TIA/EIA 568-C series: Commercial Building Telecommunications Cabling Standard.
   b. ANSI J-STD-607-A: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
   c. Comply with ITU-T (International Telecommunications Union – Telecom) for video conferencing systems.
4. Control Systems:
   a. RS485 (TIA-485): Electrical characteristics of generators and receivers for use in balanced digital multipoint systems.
   b. RS232 (TIA-232): Interface between data terminal equipment and data circuit-terminating equipment employing serial binary data interchange.
   c. RS 422 (TIA-422): Electrical characteristics of balanced voltage digital interface circuits.

1.5 SUBMITTALS

A. General
1. In addition to the requirements of Division 1, submit all materials for review arranged in the same order as the Specification, individually referenced to the Specification paragraph and Contract Drawing number. Submit 8 1/2" x 11" items bound in volumes and drawings in edge-bound sets. Submit all drawings on sheets of the same size.
2. The Contractor is to provide two copies of each hardcopy submittal and an electronic format copy (Shop drawings must be submitted as DWF. All other submittals will be provided as .PDF). All submittals must be original files or documents scanned copies will not be accepted.
3. Make each specified submittal as a coordinated package complete with all information specified herein. Incomplete or uncoordinated submittals will be returned with no review action.
4. Should the Contractor proceed with the Work of this Section in the absence of submittals for such work submitted and returned with action "No Exception Taken" or "Make Corrections As Noted", the Contractor proceeds at the Contractor's sole risk.
5. In the event that the Contractor deviates from the design shown on the audio-visual Contract Documents when preparing their shop drawings, the Contractor shall indicate with architectural style clouding, those deviations. The Contractor shall also submit with the Shop Drawings, a list of those deviations and substitutions, including the following:
   a. The deviation item number which shall also correspond to a number designation applied to each cloud on the shop drawings.
   b. Section of the specification that applies to these changes.
   c. The applicable shop drawing sheet number for each item.
   d. The corresponding audio-visual Contract Document sheet number for each item.
   e. A clear description of the deviation.
   f. The Contractor’s rational for the deviation (i.e. what benefit the deviation provides, why it is required, any cost impact, etc.).

B. Infrastructure
1. Provide drawings indicating boxes conforming and non-conforming to Consultant’s AV drawings.

C. Product Data
1. Manufacturer’s Product Data
   a. Contractor is to submit submittal in electronic format (i.e. PDF)
   b. List of materials (i.e. Table of Contents) categorized by room type: For each item specified in PART 2, include:
      1) Drawing device ID code.

2) Manufacturer.
3) Model number.
4) Listing: UL or other lab.
5) Quantity.

c. In sequence of List of Materials, provide a data sheet for each item, including all accessories marked for the proposed product.

D. Shop Drawings

1. Field (Installation) Drawings: Collate in sequence:
   a. Contractor is to submit shop drawings in .DWF format.
   b. Drawing index/symbol sheet.
   c. Floor plans. At scale of Contract Documents. Show:
      1) Device rough-in boxes with ID number.
      2) Mounting height.
      3) Conduit size.
      4) Wire type.
      5) Wire fill.
   d. Sections/Elevations. At scale of Contract Documents:
      1) Mounting location reference to nearest gridline.
         (a) Provide sections for each room containing AV equipment.
         (b) Provide elevations for each wall in rooms containing AV equipment.
         (c) Show all equipment, including speakers, monitors, projectors, podium, floor boxes, facility boxes, etc.
         (d) Provide vertical dimensions referenced above finished floor to each piece of equipment.
         (e) Provide horizontal dimensions reference to gridlines.
   e. Enlarged Plans. At scale of Contract Documents or larger as required for trade coordination. Show:
      1) Items indicated in "floor plans" above.
      2) Architectural features.
      3) Rack cabinets.
         (a) Ventilation details.
         (b) Power distribution detail.
      4) System furniture.
      5) Clearances required by applicable Code.
   f. System Conduit Riser Drawing, Show:
      1) Terminal cabinets.
      2) Coordination with floor plans.
      3) Wire runs not shown on floor plans.
      4) Wire type.
      5) Wire fill.
   g. Mounting details:
      1) Stamped and signed by an Engineer licensed in the Project jurisdiction for work of this type, where required by code.
      2) Show loads, type and strength of connections, sizes, dimensions, materials, etc.
      3) Show calculations on drawings or in bound volume for review by Authorities having jurisdiction.
      4) Provide details for:
         (a) Equipment rack anchorage.
         (b) TV Monitor mounts.
         (c) Loudspeaker mounts.
         (d) Video projector mounts.
         (e) Video displays.
         (f) Projection screens, both fixed and motorized.
         (g) Attachment to building structure.
   h. Installation details as required:

1) Terminal cabinets: Terminations.
2) Audio-Visual panel details.

i. Wire run sheets. Show:
1) Wire number.
2) Source.
3) Designation.
4) Signal type.
5) Wire type.
6) Operating level or voltage.
7) Timing reference, where applicable.
8) Physical length.

2. Shop (Fabrication) Drawings: Collate in sequence:
a. Contractor is to submit shop drawings in .DWF format.
b. Drawing index/symbol sheet (if separate set from Field Drawings).
c. System functional drawings. Submit separate drawings for each system/subsystem. Show at least:
1) Equipment:
(a) Function, make, model.
(b) Rack number, module frame and slot number.
2) Field device information
(a) Terminal cabinets.
(b) Pull boxes.
(c) Audio-visual panel connector designations.
3) Wiring
(a) Wire number.
(b) Wire type.
4) Shield condition at both ends (float, ground, location of ground).
5) Connector wiring details, each type.
6) Audio: Nominal operating level, Polarity. Note deliberate polarity inversions where required to maintain absolute polarity.
7) Video: Physical length. Electrical length in nanoseconds or degrees of sub-carrier, as applies. Equalization required.
8) Twisted pair, transmit and received devices: Transmission range at 60 Hz., cable length and signal quality.
d. Provide drawings for the following systems, if applicable:
1) Audio.
2) Video.
3) Control.
4) Data transmission.
5) Coordinated grounding scheme.
e. Equipment rack elevations: Show:
1) All racks scaled at 1 1/2" equals 1 foot, or larger.
2) Rack: Make, model.
3) Equipment: Function, make, model.
f. Rack wiring drawings: For each rack, show:
1) Power strip: Receptacles, circuiting.
2) Sequencing power and surge suppression systems.
3) Equipment.
4) Grounding.
5) Wiring, all systems.
6) Wiring harness scheme.
7) Ventilation detail.
g. Fabrication details: Submit for:
1) Receptacles.
2) Panels.
3) Special mounting provisions.

h. Legends/engraving details. Half or full size:
    1) Receptacles.
    2) Audio-visual panels.
    3) Equipment designations.
    4) .

E. Samples
1. Of all finishes/materials that will be visible to the public, including but not limited to:
    a. Receptacles and controls with associated trim plate.
    b. Each type of loudspeaker baffle and/or grille.
    c. All audio-visual panels.
    d. Audio-visual devices in public areas.

F. Programming
1. Control Programming Scheme Submittal
    a. Contractor is to submit submittal in electronic format (i.e. PDF)
    b. Provide a password-protected link to a folder on the Contractor's network to remotely access the touch panel from the Consultant's computer. Contractor is to have a dedicated control processor utilized on their network.
    c. Provide a graphic layout of each user control interface (touch panels, push buttons, etc.).
    d. Provide a list of devices that are controlled by each control user interface, including:
        1) Device.
        2) Brand.
        3) Model Number.
        4) Control Method.
    e. Provide a logic tree for each page for each control interface.
    f. Provide a system routing sheet for each control user interface, including:
        1) Source.
        2) Switcher / device input.
        3) Switcher / device output.
        4) Final destination.
    g. Provide help file content on each user interface.

G. Shop and Project Site Test Reports
1. Contractor is to submit submittal in electronic format (i.e. PDF)
2. Schedule: Submit test reports in a timely manner relative to the Project schedule such that the representative of the Owner may conduct Verification of Submitted Test Data without delay of progress.
    a. Shop test report: Submit prior to shipping completed equipment racks to Project Site.
    b. Project Site test report: Submit project site test report for this section after system completion and prior to Acceptance Review and Testing.
3. Content: Include at least:
    a. Time and date of start of burn-in.
    b. Time and date of test.
    c. Personnel conducting test.
    d. Test equipment, including serial and date of calibration.
    e. Procedures used.
    f. Results of test - numerical or graphical presentation.

H. Close Out Submittal
1. Contractor is to submit submittals in electronic format (i.e. PDF)
2. Operation and Maintenance Manuals
    a. Index.
    b. Systems operating instructions.
    c. Reduced set of system Record Drawings.
    d. Key schedule.

e. Maintenance and spare parts schedules.
f. Shop and Field Test Reports.
g. Equipment manuals. Collate alphabetically by manufacturer. Provide manufacturer's original operation, instruction and service manuals in color for each equipment item. Provide tabbed dividers between each product. Manuals provided by the Manufacturer in an individual binder may be submitted in that form.

3. Framed Operating and Maintenance Instructions: Provide adjacent to each ensemble of equipment racks. Provide sturdy frame with clear glass or non-scratching plastic cover. Provide permanent, non-fading media. Blueprints shall not be acceptable. Include:
   a. Sequence for system start-up and shutdown.
   b. System Functional Diagrams.
   c. Signal levels and impedance at accessible system signal and test ports, where applicable.
4. Record Drawings
   a. As work progresses, maintain records of "as installed" conditions. Update the set at least weekly. After successful completion of Project Site testing specified herein, and after completion of Punch List corrections, copy all records of "as installed" conditions on to final Record Document drawings, as specified in Division 1.
   b. Content: All drawings required under "Field and Shop Drawings". Show "as installed" condition. Where room designations according to Project permanent signage differ from construction designations in the Contract Documents, show both designations.
5. Provide four copies on CD-ROM containing the “as built” drawings, all manuals, training manual and programming code.
   a. Submit un-compiled programming code.
6. Training Submittal
   a. Provide all training materials for review prior to scheduling training sessions.
      1) Training manual.
      2) Agenda for the training session.
      3) The final punch list, indicating that all equipment is fully functional.
   b. See the section under Owner’s Instructions for training manual requirements.
   c. No training session will be scheduled until final punch list is completed and submitted.
7. Warranty Certificates
   a. Comply with Division 1.

1.6 QUALITY ASSURANCE

A. Qualifications
   1. The bidder shall, prior to the bid, in accordance with the Instruction to Bidders, submit at least the following information to verify that the bidder has the necessary experience and qualifications to perform the specified work:
      a. A detailed brochure describing the bidder’s capabilities in terms of facilities, personnel (include a personnel organization chart followed by resumes), experience, background, examples of similar installations (at least two projects within the past two years), distribution arrangements with manufacturers and financial capability, including certificates of insurance and satisfaction of the project bonding requirements.
      b. Contractor must, at the time of this bid submittal, have distribution or a dealership agreement with all manufactures whose products are specified in the bid documents. Contractor must also have completed manufactures training and certification before bids are submitted.
      c. Information identifying any and all local agents and/or subcontractors that will assist in the work and their role in the project.
      d. Identification of sources of labor for all fabrication and installation throughout the duration of the project.
      e. Evidence that he has acquired all necessary licenses, certificates and approvals to perform the specified work within the state or jurisdiction the work is to be performed.

2. Projects that include networked audio or video systems will require the Contractor to submit the name of the person, in their employment, qualified to perform this work. This person shall have certification in computer network technology and hold one of the following certifications:
    a. CNP – Certified Network Professional Program.
    b. Computing Technology Industry Association - Network+ certification.
    c. MCSE – Microsoft Certified Systems Engineer.
    d. CNE – Certified Systems Engineer.
    e. CCNA – Cisco Certified Network Associate.
3. Projects that include software configurable, integrated central control systems must include, as a sub-contractor, an authorized independent programmer who is fully engaged in the work of programming. The Contractor is to enter into an agreement utilizing the authorized independent programmer as a sub-contractor. Under this agreement, the Contractor will retain all of the responsibility for a complete and working system. The Contractor must include in their bid time to work out any programming glitches that may occur in the initial programming stage. These items include working through the initial and final programming stage with the authorized independent programmer to provide a functional system, testing the programmer's graphical user interface for intended functionality and provide onsite support for the programmer in the uploading and testing of programming revisions. The control systems programmer shall be present either by web meeting or in person at the end user interviews to acquire information first hand. The control systems programmer shall submit a report outlining the meeting results to Contractor for approval. Only when the Contractor approves this report shall it be submitted to the consultant for review. If the contractor does not employ a fulltime programmer, the following companies have been approved subject to above.
4. The Contractor will provide information on how and by whom the requirements of the warranty period will be fulfilled.
5. The submittal must justify, in the judgment of the Consultant, the Architect, and the Owner, that the Contractor has the capability to manage and install a project of this size and scope and that he is capable of the necessary business and technical arrangements for this installation and the pursuant warranty service. Contractor may be disqualified as a bidder if all of the submittal does not meet the approval of the Owner and his/her representative.
6. Company: Work of this Section shall be performed by a Sound or Audio-Visual Systems Contractor who has at least five years direct experience with the devices, equipment and systems of the type and scope specified herein, and who has a fully staffed and equipped maintenance and repair facility, and who is licensed to perform work of this type in the Project jurisdiction. The company must be NSCA R-ESI or CTS certified.
7. Personnel: Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work of this Section. Supervisors shall have at least five years direct experience in similar work. Installation and maintenance personnel shall have at least three years direct experience in similar work. Contractors shall have at least 60% of their installation staff CTS or C-EST certified.
8. Designated Supervisor: Provide a designated supervisor present and in responsible charge in the fabrication shop and on the Project Site during all phases of installation and testing of the Work of this Section. This supervisor shall be the same individual throughout the execution of the Work unless illness, loss of personnel, or other circumstances reasonably beyond the control of the Contractor intervene.

9. Staff Engineer: The Contractor shall have on his full-time payroll at least one staff engineer having five years minimum experience as an electronics engineer covering systems and projects comparable in substance and complexity to the project described herein. The staff engineer shall have NICET certification in Electrical/Electronics Engineering Technology and Audio Systems or equivalent. The signature of that engineer shall appear on all shop drawings and submittals.
10. Coordination: Coordinate the Work of this Section with the Work of all other Separate Contracts. Comply with Division 1.
11. Help Desk: The Contractor must employ a fully staffed help desk department that shall provide knowledgeable responses to inquiries regarding system operation. This department must also have the ability to provide remote diagnostics to identify equipment faults for troubleshooting.

B. Cutting and Patching
1. Cut, patch and extend existing work using skilled mechanics that are capable of matching existing quality of workmanship.
2. Assign work of moving, removal, cutting and patching, to trades qualified to perform the work in a manner to cause least damage to each type of work, and provide means of returning surfaces to appearance of new work.
3. Perform cutting and removal work to remove minimum necessary, and in a manner to avoid damage to adjacent work. Cut finish surfaces such as masonry, tile, plaster or metals, by methods to terminate surfaces in a straight line at a natural point of division.
4. When new work abuts or finishes flush with existing work, make a smooth and workmanlike transition. Patched work shall match existing adjacent work in texture and appearance so that the patch or transition is invisible.
5. Protect existing finishes, equipment, and adjacent work that are scheduled to remain, from damage.
6. Promptly repair damages caused to adjacent facilities by demolition operations, at no change in Contract Amount.

C. Painting
1. Use skilled mechanics that are capable of painting audio-visual equipment and hardware to match architectural surroundings, where applicable.

D. Regulatory Requirements
1. Regulations Applicable: including but not limited to those defined in Division 1.
2. Comply with all applicable federal, state, and local labor regulations, and applicable local union and trade regulations.
3. Installation practices shall be in accordance to industry-accepted standards (ANSI, Cal-OSHA, IEC, IEEE, FCC, NEC, NFPA, ICIA, NSCA, CEDIA, BICSI) or local acts, codes and standards enforced at the place of work, whichever is most stringent.
4. Procure and pay for all necessary permits, licenses, inspections, and observe any requirements stipulated therein.
5. Provide UL/ULC fire rated enclosures around all audio-visual floor and back boxes where required by code.

E. Programming
1. User Group Interview:
   a. Conduct interviews with the end-users to acquire programming requirements. Submit written results of the interview and the requirements set forth by the user group. Associate the user group requirements into the programming of each sub system. Submit to the Consultant a report that outlines the interviews conducted.

F. Pre-installation Meetings
1. Attend a pre-installation meeting at the project site with the Owner and his representatives in order to coordinate related work and scheduling issues.

G. Verification
   1. Verify dimensions and conditions at the Project Site. Submit any conflicts in timely manner for resolution.

H. Shop Fabrication and Testing
   1. Assemble and fully wire equipment racks at a fabrication shop off the Project Site. Burn-in for not less than 120 hours. Following burn-in, perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Submit verification of shop test in timely manner. Following verification of shop test and when installation locations are ready as specified herein, deliver equipment racks and equipment to the Project Site and install.

I. Project Site Installation and Testing
   1. Install as specified herein.
      a. Perform specified adjustment procedures. Provide test equipment and test according to procedures specified herein. Request verification of Project Site test in timely manner.

J. Verification of Submitted Test Data
   1. Re-test in presence of designated representative(s) of the Owner at reasonable mutual convenience. Provide services of the designated supervisor and an additional technician familiar with work of this Section. Provide all test equipment. Provide complete set of latest stamped submittals of record for reference. Provide complete set of Shop and Project Site Test Reports, as applies. Provide a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.

K. Reference/Project Record Documents
   1. At all times when the work is in progress, maintain at the workplace, fabrication shop or Project Site as applies, a complete set of the latest stamped, action submittals of record for reference. Also maintain a separate, clean, undamaged set for preparation of Project Record Documents. Also maintain at the workplace a complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.

1.7 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading
   1. The Contractor will take receipt of all Owner Furnished Equipment at the project site or at a local warehouse.
   2. Deliver materials in manufacturer's original undamaged packages or in bulk packing which provides equivalent protection from rough handling, dust and dirt.
   3. Deliver all assembled equipment racks in custom manufactured wood crates to avoid damage during shipping. Contractor is to hire a crate manufacturer to build crates prior to delivering racks to the jobsite.
   4. All packing, shipping, insurance, handling and storage costs of equipment and materials shall be the responsibility of the Contractor.
   5. The Contractor shall be responsible for insuring all equipment and installation materials stored in their shop facilities until it is delivered to the Project Site and a delivery acknowledgement is received from the Owner or its authorized representative.
   6. Equipment unpacked for inspection but not ready for permanent installation must be returned into its protective packing.
   7. The Contractor shall be responsible for furnishing a temporary substitute for equipment that could not be delivered in time for system operation. All costs associated for renting, shipping and handling temporary substitute equipment shall be the responsibility of the Contractor.

8. In the event the equipment or installation material delivery is delayed, the Contractor must employ the fastest means of delivery service available to deliver the equipment on time. All costs for expediting the delivery of equipment shall be the responsibility of the Contractor.
9. Store packaged materials off of the ground or slab in a manner to protect them from elements, especially moisture damage.
10. Deliver completed, wired, tested equipment racks to associated equipment rooms at the Project Site when major work of all other separate contracts is complete, equipment room ventilation is operating with clean filters in place, the area is clean and free from airborne contaminates, and continuing work of other trades will not produce airborne contaminates or permit transport of such airborne contaminates to the equipment rooms.

B. Acceptance at Site
1. All equipment and installation material delivered to the Owner shall be properly documented in the form of delivery receipts.
2. Equipment delivered to the Project Site must have a delivery acknowledgement receipt signed by the Owner or its representative. Issue a signed copy of the delivery receipt to the Owner and file the signed copy for future reference.
3. The Contractor shall be responsible for the insurance coverage and security of equipment delivered to the Project Site until it receives an acknowledgement of delivery from the Owner or its authorized representative.

C. Storage and Protection
1. The Contractor shall provide a safe and secure storage location for all equipment and installation materials until they are delivered to the Project Site and it receives an acknowledgement of delivery from the Owner or its authorized representative.
2. For equipment assembled and tested at the Contractor's shop facility and delivered to the Project Site, ensure that the equipment is properly protected from improper handling, rain, water, humidity, moisture, heat, direct exposure to sunlight, dust and dirt during delivery and storage on or off the Project Site.
3. Do not remove protective packing from equipment until they are ready to be installed.
4. If, after equipment is installed, the Project Site cannot be cleaned or is still not clean because of on-going work by others, provide protective covering and protection to prevent airborne dust and dirt originating from damaging equipment.

1.8 PROJECT SITE CONDITIONS

A. Environment Requirements
1. The spaces where audio-visual system assemblies are installed shall meet the following requirements:
a. Free from dust generated from construction.
b. The room temperature shall be within the specified operating temperature recommended by the manufacturer.

1.9 SEQUENCING

A. Submit all testing documentation to the Owner's Representative for review prior to requesting the Fabrication Inspection and Substantial Completion inspections.

B. Allow adequate time for corrections to be made after inspections to maintain the Project Schedule.

1.10 SCHEDULING

A. Comply with the Project schedule.

B. Make all Submittals specified herein in a timely manner. Failure to make timely submittals complete as specified herein is considered to be lack of substantial progress of the Work of this Section. Contractor is to work around client schedule throughout the duration of the project.

C. Deliver all equipment, devices and materials required for the Work of this Section and install, test and ready all work for Acceptance Testing at least fourteen days prior to the completion date for the associated area of the Project, unless specifically instructed otherwise by the Owner.

D. Temporary Equipment: Provide and operate, without claim for additional cost or time, temporary equipment and/or systems to provide reasonably equivalent function, as determined by the Owner, in lieu of the Work of this Section which is incomplete or found not in conformance with the Contract Documents as of seven days prior to the completion date. Provide such temporary equipment until Acceptance of the Work of this Section. Thereafter, remove such temporary equipment.

E. It shall be a common understanding that there is a time constraint when executing this work. The Contractor shall use all means and resources to complete this project on or before the specified schedule at no additional cost to the Owner. This includes working beyond normal business hours and days, additional manpower, additional tools, etc.

1.11 WARRANTY SERVICE

A. Warrant all Work of this Section to be free from defects in materials and workmanship for a minimum of 2 years from the date of Owner acceptance of the Work of this Section.

B. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty may be voided. In such cases, provide a warranty equivalent to that of the original manufacturer.

C. All high-level software shall follow the warranty conditions specified by the manufacturer. Immediately update or upgrade the Owner's installed software as soon as new versions, updates or patches become available from the manufacturer at no additional cost to the Owner within this warranty period.

D. Response Time: Provide a qualified technician familiar with the work at the Project Site within 12 hours after receipt of a notice of malfunction. Provide the Owner with the telephone number attended 8 hours a day, 5 days a week, and an answering service or equivalent facility attended 24 hours a day, 7 days a week, to be called in the event of a malfunction. Provide repairs at no expense to the Owner and at the Owner's request, alternate facilities, services and systems for the duration of the repairs to any defective work of this Section. Provide a complete and operational System, within 48 hours after notification of a malfunction.

E. All work requested due to warranty issues shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.

F. The Contractor shall use qualified service personnel to respond to all warranty issues or calls.

G. Off Site Service: Conduct all warranty repairs and services at the Project Site, unless in violation of manufacturer's standard product warranty. Provide substitute systems, equipment, and/or devices acceptable to the Owner for the duration of off-site repairs. Provide transportation for substitute and/or test systems, equipment, devices, materials, parts and personnel to and from the Project Site.

1.12 OWNER'S INSTRUCTIONS

A. General
   1. Conduct training on the completed system at a reasonable convenience of the Owner during normal Owner business hours. Contractor is to assess the complexity of the system and shall fully train the operation and maintenance staff named by the Owner.

2. Do not start training until all systems have been commissioned, training manuals are approved and an agenda along with schedule of each departmental training session has been submitted to the owner.
3. Training will be conducted in the actual room that is the topic of the training session.
4. The client asserts legal and beneficial ownership of all training materials which are specifically commissioned for this project.

B. Operator Training – Do not start training before system is in full operation and all components have been signed off by owner's representative. Use the items covered in the commissioning portion of this specification as a basis for the training curriculum.
   1. At least two 4-hour sessions of instruction will be given in order to familiarize the Owner with the operation of the system.

C. Maintenance Training
   1. At least two 3-hour sessions of instruction will be given in order to learn how to maintain and troubleshoot the system. A maintenance binder shall be provided by the Contractor with all manufacturer-specific operating and maintenance information for each piece of equipment used. On large jobs, the binders will be sub-divided into individual audio, video and control binders. Provide training on at least the following system features:
      a. Firmware upgrades
      b. Helpdesk features
      c. Complete use of system as outlined in the Commissioning section plus advanced troubleshooting.

D. Training Video
   1. A training video shall be produced and cover all aspects of the systems operation.
   2. Each page of all user interfaces shall be explained and recorded while gestures are made on the screen. Each button on the user interface shall be explained and demonstrated.
   3. All portable equipment that connects to the system shall be demonstrated both in their physical connection and routing method at the user interface.
   4. All patch bays shall be explained and demonstrated.
   5. All source equipment shall be explained in both physical loading of media and transport control as well as user interface control.
   6. Demonstrate on basic troubleshooting.
   7. Provide training on items as outlined in the Commissioning section of this document.
   8. Demonstrate system start up and shut down.
   9. Explain and demonstrate help files associated with touch panels.
   10. Audio and video files shall be combined and burned to DVD for distribution to each department.
   11. Provide professional DVD with searchable index of topics covered.
   12. Provide label with client's logo, room name/number, title, length and topics covered.

E. A training manual specific to this system will be written covering the basic and advanced functional techniques necessary to operate the system in a reliable and fully-functional condition. The Contractor shall submit hard color copies of the training manual as well as a soft copy in PDF or DOC format. Provide a hard copy of the training manual for each person to be trained. This manual will include:
   1. All contact information, including emergency and after hours phone and pager numbers, for requesting service assistance from the Contractor.
   2. A 11x17 set of as-built drawings of the completed project (a full-sized set will be issued to the client for their use, a half-size set will be attached to the inside back door of the main equipment rack).
   3. A table of contents at the beginning of the manual.
      a. The manual will begin by explaining basic information such as manual references, abbreviations, any assumptions made by the author, prerequisites required, numbering convection, etc.
      b. It will then proceed to the manual objectives.

c. Explain what the end user should understand after reading the manual.
d. It will cover the basics of the user interface including start up and shut down procedures, log on procedures, access privileges, operator password, levels of security, file structure, etc.
e. The manual will proceed to describe each user interface and its function. It will cover every layer of the interface and how to navigate through them.
f. Each of the system presets will be explained and the physical setup of the equipment and floor plan during presets will be illustrated. Source equipment such as CD players, Cassette, VCR, etc. shall have their routing scheme explained and illustrated. Portable equipment and its connection to the system shall be explained and illustrated.
g. The manual will end by explaining basic troubleshooting procedures and equipment care instruction.

4. The Contractor's maintenance instructions, which will include the manufacturer's maintenance instructions found on the factory manuals to keep the manufacturer's warranty in force.
5. A list of consumables (lamps, fuses, batteries, etc.) required to keep the system operating over time, along with sources of supply (if not readily available).
6. The Contractor will compile and submit all factory warranty registration forms or cards for each piece of equipment furnished for this project.
7. A form requesting feedback from the end user as to how the manual should be improved and a section to report errors discovered.
    a. The Contractor will make the corrections and improvement suggestions after receiving feedback from the users. This will be completed at no charge to the client. The manual will contain a date stamp and version number. Each feedback and error correction manual reissue will include a new version number.

F. Initial Use Support
    1. Provide standby trainer/system engineer during the first two public events.

1.13 MAINTENANCE

A. The Contractor shall, within the warranty period, schedule two visits to inspect and perform preventive maintenance on the system. The first visit shall be six months after the commencement of the warranty period. The last visit shall be just prior to the end of the warranty period.

B. Return 90 to 120 days after the system has been turned over to the Owner for additional programming, maintenance and system fine-tuning. Conduct interviews with the user group via telephone to acquire information needed to complete this task. Allow for one full day of programming in your initial bid to complete. Provide a per hour programming fee that will be charged if additional programming is needed.

C. Cache for event logging must be set to record unlimited events until the Contractor's first maintenance site visit. After the Contractor's first maintenance site visit, the cache can be limited to the Owner specified level.

D. The Contractor shall use qualified service personnel to conduct all maintenance work.

E. All maintenance work shall be performed during regular working hours unless the Owner agrees to pay the difference in labor rates for overtime or night time work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Quality of Products
   1. Materials and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the specified systems.
   2. Where a particular material, device, piece of equipment or system is specified directly, the current manufacturer's specification for the same shall be considered to be a part of these specifications, as if completely contained herein in every detail.
   3. Each material, device or piece of equipment provided herein shall comply with all of the manufacturer's published specifications for that item.
   4. Equipment shall be from the manufacturers' current stock and shall not be stored longer than 1 year prior to installation, unless written approval to do otherwise is provided by the manufacturer and submitted for review by the Owner.
   5. All products will be a product of firms regularly engaged in the manufacturing of electrical, electronic or optical equipment. The equipment will be the latest model or type offered which meets the applicable specifications at the time of the submittal. Discontinued items replaced by newer models or versions are prohibited and should not be submitted for review.
   6. Quality of workmanship and fabrication of all equipment and components, which are custom fabricated, shall be comparable to professional equipment produced by specialized manufacturers of the trade involved and will be verified by inspection. Only firms having 5 years of experience in all aspects of the fabrication and installation of similar systems will be allowed to perform the work.
   7. All materials and products will be new and of professional quality. Unless specifically stated in the drawings or specifications, no existing or used materials will be installed.

B. Quantity
   1. Provide the quantity of products as shown on the Contract Drawings, or as otherwise indicated herein.
   2. The equipment listed in section 2.2 consists of all major equipment for the project. The Contractor will integrate into the system design and provide any additional components, wiring, programming, etc., to complete a functional system operating as described within the specifications and the category AV drawings.
   3. Components or equipment not specified or indicated on the drawings that are required to make a fully functional systems per the Owner's requirements and the design intent, shall be furnished and installed by the Contractor, and shall be submitted for Owner review.

C. Preference
   1. Where more than one manufacturer is listed herein as acceptable or equivalent, no preference is intended or implied by the order of listing.

D. In the event that a specified piece of equipment or product has been superceded, discontinued or is no longer available from the manufacturer, the Contractor shall submit a request for substitution of the originally specified product. The substitute product shall be the manufacturer's most current model of the specified product, or if the line has been discontinued, a product by the same manufacturer with specifications meeting or exceeding, and as close as possible to those of the originally specified product. Refer to Alternatives and Substitutes section for clarification.

E. Deferred purchase of equipment, including computers, touch panels, flat panel displays and video projectors with short market life expectancy
   1. Applies to the installation of equipment that is scheduled to take place more than 8 months after the bid has been awarded.
   2. Contractor shall, with his bid, breakout pricing for the above mentioned equipment and provide an allowance for these items.

3. Ninety Days prior to its purchase, the Contractor shall submit for the Consultant's approval, a list of the equipment that has replaced or superseded the specified equipment.
4. The submittal will include the manufacturer's specification sheets and other documentation to verify that the equipment meets the standards of the original specification.
5. In the event that the Contractor's allowance for the equipment to be installed exceeds the current pricing, the price differential shall be returned to the Owner as a credit. The credit shall include the current price differential plus markups for overhead and profit and shall be documented in writing.
6. In the event that the current pricing exceeds the allowance, the Contractor shall submit a detailed cost breakdown clearly indicating the current pricing differential and all markups requested.

F. Provide Complete
1. Provide all auxiliary and incidental materials and equipment necessary for the operation and protection of the Work of this Section as if specified in full herein.

G. Provide New
1. All materials provided under the Work of this Section shall be new, shall be the manufacturer's latest design/model, and shall be permanently labeled with the manufacturer's name, model number and serial number.
2. Products and materials shall be clean, free of defects, damage and corrosion.

H. Similar
1. Similar devices shall be of the same manufacturer, unless specifically noted otherwise in these specifications.

I. Safety Agency Listing
1. All devices provided under the Work of this Section that are connected to the Project electrical system shall be listed by Underwriters Laboratories (UL) or other Nationally Recognized Electrical Testing Laboratory acceptable to the Authorities having jurisdiction at the Project site, and shall be so labeled. Absent such listing, comply with Regulatory Requirements applicable to Unlisted Equipment.

J. Unlisted Equipment
1. Certain equipment specified herein may not bear listing by a Nationally Recognized Testing Laboratory. Such equipment is specified herein only where no equipment is known to exist bearing such listing which that perform the function required by the Owner. In such case, apply for field inspection of such equipment. The Contractor is responsible for the payment of such inspection costs.

K. Power Rating
1. All devices provided under the Work of this Section that are connected to the Project electrical system shall provide stable performance in full accordance with these specifications when operated on main service which complies with ANSI standard tolerances for voltage, frequency, transients and related parameters.

L. Circuit Protection
1. All active devices shall have integral fuse or circuit breaker protection.
2. All circuit breakers shall be fully magnetic.
3. Protection devices shall be located to facilitate examination, resetting and/or replacement without the need to disassemble or demount the associated device.
4. Contractor-fabricated items shall be provided with either indicating type circuit breakers or fuses of the clear glass cartridge type, mounted in fuse holders which will indicate a blown or defective fuse.

M. Continuous Use

1. All active circuitry shall be solid state and shall be rated for continuous use. All circuit components shall be operated in full compliance with the manufacturer's recommendations and shall contain sufficient permanent identification to facilitate replacement.

N. Construction
   1. All electronic equipment shall be of the "dead-front" type and shall be designed for standard 19" EIA rack mounting, unless otherwise indicated.
   2. Steel frames and enclosures shall be designed and wired to eliminate all induced currents within both the units and the systems.
   3. All bolted connections shall be made with self-locking devices.
   4. Coordinate all consoles and panels so that the general appearance is similar, or as directed by the Owner.
   5. All operating panels shall be at least 1/8" thick aluminum.
   6. Provide locking panel covers on all recessed, semi-recessed or surface mounted control panels not located in the equipment rooms, unless specifically noted otherwise. Panel locks shall be flush with no protrusions beyond the panel face when the door is closed. Recessed control panels shall be recessed within the back box to a depth sufficient to permit a locking hinged panel cover to completely close without affecting any device within the enclosed area.

O. Circuit Boards/Modules
   1. All printed circuit boards or modules shall be mechanically secured by bolt or friction-loading guide, in addition to any electrical connector attachment, and shall include an integral extraction grip.
   2. Printed circuit boards shall be connected to associated circuitry via soldered connections or precious metal positively keyed card edge connectors.
   3. All Contractor-fabricated printed circuit boards shall be at least 1/16" thick G-10 glass fabric epoxy base, copper plated to a minimum density of 2.0 oz./sq. ft. on one or both sides, and finished with 60/40 tin/lead solder either hot rolled or plated over the copper. All holes through the boards shall be plated through and solder filled. All boards shall be permanently identified with a designation that matches that of the mating connector or board position in the assembly.

P. Identification
   1. Provide permanent intelligible identification on, or adjacent to, all connectors, receptacles, controls, fuses, circuit breakers, patching jacks, and the like. This identification shall clearly and distinctly indicate the function of the item and shall be numbered or lettered to correspond with the function, circuit and location consistent with field and shop drawings. Refer to section 3.5 for clarification.

Q. Modular Products
   1. The drawings show conventionally packaged components to convey design intent.
   2. Card cages to have front and rear closure panels to provide a finished appearance.
   3. Except as noted below, modules of different functional types are permitted to share the same card cage/mounting frame and/or power supplies as applicable and if mechanically and electrically compatible.
   4. With amplifier input driven 10 dB beyond input level required to produce full rated output, amplifier shall withstand indefinitely any of the following load conditions without instability of operation of main over current protection (i.e. no blown fuses or circuit breakers).
      a. "Short" circuit of 0.1 ohm.
      b. Open circuit (no load).
      c. Rated load impedance.
   5. Maintain sense of signal polarity from input to output.

R. Keys
   1. Key all boxes, cabinets, enclosures, panels, controls, doors and related provided for similar usage within a system identically. For each unique key type, provide a quantity of ten. Stamp each key with a reference designation. Provide a master keying system.

2. Submit a schedule of keying to the Owner. Where so noted, provide Project Standard lock cylinders and keys; coordinate with the work of other Sections.

S. Lectern Power Cord
   1. The power outlet connecting the lectern to the floor box must be twist-lock type. The power cord connecting the podium to the floor box must be 12 inches shorter that the low voltage cable connecting it. This will protect the low voltage cable from damage if the podium was to be moved inadvertently without disconnecting the cables. The power cable shall include a wire-rope strain relief to keep the power cord from damage. See cable detail on plan-set for more information.

T. Assistive Listening System (RF)
   1. An assistive listening system using wireless radio frequency (RF) transmitter and headsets will allow personal monitoring of the audio program for the hearing impaired. The transmitter will be a frequency agile unit with no less than 30-channel capability and will broadcast the main audio program to personal headsets used by hearing impaired audience members. The system and quantity of headsets supplied shall conform to the ADA requirements (section 219 and 706) for the space. Stereo headset type and hearing aid compatible (T-Coil) listening devices are required; ear-bud type devices are not acceptable. Supply a drop-in type battery charging system capable of servicing multiple receivers, with sufficient charging capacity to charge each receiver simultaneously. Follow the table below for quantity requirements.

Capacity of Seating in Assembly Area	Minimum Number of Required Receivers	Minimum Number of Required Hearing Aid Compatible Receivers
50 or Less	2	2
51 to 200	2, plus 1 per 25 seats over 50 Seats *1	2
201 to 500	2, plus 1 per 25 seats over 50 Seats *1	1 per 4 Receivers *1
501 to 1000	20, plus 1 per 33 seats over 500 *1	1 per 4 Receivers *1
1001 to 2000	35, plus 1 per 50 seats over 1000 seats *1	1 per 4 Receivers *1
2001 and over	55, plus 1 per 100 seats over 2000 seats *1	1 per 4 Receivers *1

*1 Or fraction thereof

U. Projection Screens
   1. Provide extra screen material drop to locate the projection screen at the optimum viewing angle where required. Verify screen drop requirements with architectural sections and elevations.

V. Provide enclosure systems including, but not limited to racks, cabinets, cases and related panels and accessories as specified herein, or approved equivalent. Provide size and quantity as shown on drawings. Provide color as specified by Architect. If no color is shown on drawings, submit manufacturer's standard color chips for selection.

W. Cable Tray: Provide aluminum ladder style cable tray with flange in side rails where called out in drawings. Size the cable tray to accommodate all wire that must pass through it. Provide all supporting hardware and accessories.
   1. Ladder Style Cable Tray
      a. P-W Industries.
      b. Equal by Hubbell.
      c. Approved equal.

X. Floor Mounted Equipment Racks: Provide each bay with basic frame, vented locking rear door, top panel with single 10” fan, certified seismic floor anchor kit, ganging hardware, except where otherwise indicated, at each ensemble of bays, provide end (side) panels to provide complete enclosure.

1. Rack cabinet, heavy duty welded 14ga. CRS, single bay of maximum dimensions 83-1/8"(H) x 24"(W) x 32.5"(D); floor supported with accessory louvered side rack side panel.
    a. Mid Atlantic WRK Series.
    b. Equal by Atlas/Soundolier.
    c. Approved equal.
2. Wall cabinet, tilt out:
    a. Atlas/Soundolier AWR Series.
    b. Mid Atlantic WRS Series.
    c. Equal by House of Metal Enclosures (HOME).
    d. Equal by Hammond Manufacturing.
3. Wall Mounted cabinet:
    a. Atlas/Soundolier 300 Series.
    b. Mid Atlantic DWR Series.
    c. Equal by Hammond Manufacturing.

Y. Rack Panels and Accessories: Rack Mounting Screws: Screws 10-32; length as required for at least 1/4" excess when fully seated; oval head with black plastic non marring cup washer or equivalent ornamental head; nickel, cadmium or black plated; Phillips, Allen Hex, Square-Tip or Torx drive. Slotted screws are not acceptable.
    1. Blank Panels:
        a. Atlas/Soundolier S19 Series.
        b. Zero ZP112000 Series.
        c. House of Metal Enclosures (HOME) Series PM.
        d. Middle Atlantic Products BL, SB or HBL Series.
    2. Vent Panels:
        a. Middle Atlantic ETF Series.
        b. Equal by Atlas/Soundolier.
        c. Equal by Zero.
        d. Equal by House of Metal Enclosures (HOME).
    3. Shelf:
        a. Middle Atlantic Products U Series.
        b. Atlas/Soundolier SH19 Series.
        c. Zero A52 Series.
    4. Drawer:
        a. Atlas/Soundolier SD Series.
        b. Middle Atlantic Products UD Series.
        c. House of Metal Enclosures (HOME) SD Series.
        d. Zero A43/A36 Series.
    5. Compact Disc Holder: Middle Atlantic Products Model RSH-4A.
    6. Rackmount Computer Keyboard: Middle Atlantic RM-KB.
    7. Equipment Custom Rackmount Shelf: Middle Atlantic Products Model RSH-4A Series.
    8. Rackmount Computer Keyboard.
        a. Mid Atlantic RM-KB series.
        b. Approved equal.
    9. Computer Monitor Rackmount.
        a. Mid Atlantic RM-MM series.
        b. Approved equal.
    10. Horizontal Lacer Bars
        a. Mid Atlantic LBP-IR4, LBP-1S, LBP-1P.
        b. Equal by Atlas/Soundolier.

Z. Equipment Enclosure Ventilation: Provide UL Recognized devices. Connect to enclosure power, comply with applicable Codes.
    1. Fan panel, 5 1/4" high painted steel rack panel with 4" diameter fans, each fan with chrome plated finger guard, low speed air flow, two fans per panel, total 120 CFM:
        a. Mid Atlantic QFP-2 Series.

b. Atlas/Soundolier ES/IS Series.
c. BGW Systems.

2. Thermostatic Fan control module, user definable temperature range with status LED's, temperature sensing probe.
   a. Middle Atlantic FC Series.
   b. Atlas/Soundolier CFT Series.

AA. Equipment Enclosure Power and Signal Grounding: Comply with applicable Codes and applicable portions of Division 26. Provide UL Listed devices, Specification or Hospital Grade. Provide all junction boxes, raceway, fittings, wire, supports and fastenings as required for complete installation. Unless otherwise noted, provide receptacles of NEMA 5-15R configuration.

1. Full height receptacle strip, Isolated Ground:
   a. Wiremold 3000 Plugmold IG Series.
   b. Middle Atlantic PD series vertical power strips.
2. Full height receptacle strip, three or more circuits, Isolated Ground:
   a. Wiremold 3000 Series with Specification Grade IG 5262 Series receptacles.
   b. Middle Atlantic PD series vertical power strip.
3. Wireway, lay in, NEMA 1: Any meeting NEMA 1 and UL870. Size as required.
4. Flexible metal conduit: Comply with Division 26.
5. Sequencing Power System:
   a. The Contractor is to design and build power sequencing and surge suppression systems that will control and distribute power in the equipment racks. The system will be designed to sequentially connect power to all of the audio-visual equipment in the equipment racks. Outlets are mounted to the unit's back plate or on a remote strip. If the project utilizes a control system, the sequencing power system will be controlled by the software configurable control system. The touch panel's shut down button will prompt a second time asking "Are you sure you want to shut the system down?" A positive response will activate system shut down. A push button control station's shut down button will be pressed twice to shut down the system. If the project does not include a control system, the Contractor is to provide a dedicated sequential controller in the equipment racks.
      1) 15 amp or greater power capacity.
      2) 3-prong 15 amp 120VAC isolated ground outlets (provide required amount).
      3) Individual sequencing steps for each outlet.
      4) Adjustable power-up time delay and outlet sequencing intervals.
      5) Modular power raceway systems shall be constructed of 18-gauge min-spangle galvanized steel.
      6) Remote controllable via contact closures (if applicable).
      7) Status indicator on touch panel (if applicable).
   b. Approved subject to above:
      1) Middle Atlantic RLM-XX, RM-XX, R-XX or M-XX Modular Power Raceway Series.
      2) Middle Atlantic USC-6R Universal Sequencing Controller.
      3) Equal by Atlas Soundolier.
6. Signal Grounding bus bar, insulated from enclosure frame:
   a. Atlas/Soundolier BBG Series mounted on standoff insulators.
   b. Zero A32 Series.
   c. Middle Atlantic.
   d. Panelboard Isolated Ground bus kit by manufacturer of Project Panelboards specified in Division 26.
7. Multi-Outlet Assembly, Surge Suppressing, UL Listed. Comply with ANSI/IEEE C62.41-1980. Provide at least six receptacles. Provide equivalent to:
   a. Surgex SX RT series.
   b. EFI Electronics Corporation Model 153.
   c. MCG Electronics, Inc. Model 296 (subject to UL Listing).

8. Computer Grade Uninterruptible Power System, UL Listed. Provide continuous, no-break power with sine wave output. Provide Transient Over-Voltage (TOV) Surge Suppression; comply with ANSI/IEEE C62.41-1980, Category A and Category B. Provide complete isolation from Line. Provide output voltage regulation to ANSI C84.1 for computing equipment. Provide output KVA, switch-mode power supply rated, not less than 150% of connected load indicated. Provide one for each Central Processing Unit, Digital Signal Processor and automated control console. Provide equivalent to:
   a. Best Power Technology, Inc. "Micro-Ferrups" Series.
   b. Best Power Technology, Inc. "Axxium" Series.

BB. Data Patching and Related:
1. Data Patching Jack Assemblies; jackfield two times twenty four (2x24) jacks. Meet or exceed Category 6 requirements described in TIA/EIA-568-C.2-1 as well as the Class E requirements described in ISO/IEC 11801-B.:
   a. Leviton eXtreme 6+ Quickport Patch Panel (or equal).
2. Provide patch cords for patch points as required.

CC. Fiber Patching and Related:
1. Fiber Patching Jack Assemblies. Meet or exceed all TIA/EIA-568-C requirements:
   a. Leviton Opt-X Ultra Fiber Rack Mount Enclosure (or equal).
2. LC type adapters.
3. Provide patch cords for patch points as required.

2.2 PRODUCTS

A. Major System Components

DEVICE_ID	DESCRIPTION	MANUFACTURER	MODEL	ACCESSORIES
ALA	ASSISTIVE LISTENING ANTENNA	WILLIAMS SOUND	ANT 034	
ALR	ASSISTIVE LISTENING RECEIVER	WILLIAMS SOUND	PPA SELECT PPA (R37)	HED 021
ALS	PORTABLE CASE	PELICAN	1450	
ALT	ASSISTIVE LISTENING TRANSMITTER	WILLIAMS SOUND	PPA T45	
ANT	ANTENNA	SHURE		
BDP1 (OFCI)	BLU-RAY DISC PLAYER	SONY	BDP-S1500	
CAM	POE CAMERA	AXIS	P5515 PTZ	T94A03L RECESSED CEILING MOUNT KIT
CPU (OFCI)	CENTRAL PROCESSING UNIT	DELL		
CT1	CONTROL	EXTRON	MLC PLUS 100	
CVM (OFCI)	COMPUTER VIDEO MONITOR	DELL		
DC (OFCI)	DOCUMENT CAMERA	ELMO	TT-12iD	
KB (OFE)	KEYBOARD			
LEC1(OFCI)	LECTERN	SPECTRUM INDUSTRIES	55357BKBS10112010	
LPM	LAPEL MICROPHONE	SHURE	WL185	
M (OFE)	MOUSE	MICROSOFT COMPATIBLE		

DEVICE_ID	DESCRIPTION	MANUFACTURER	MODEL	ACCESSORIES
M1	MICROPHONE INPUT	FSR	T3-MJ	
NI1	NETWORK INTERFACE	GLOBAL CACHE	GC-100-06	
NI2	NETWORK INTERFACE	GLOBAL CACHE	IP2CC	
PA100/2V	POWER AMPLIFIER	EXTRON	XPA 1002-70V	
PA30/2V	POWER AMPLIFIER	EXTRON	MPA 152 PLUS	
PJS1	PROJECTION SCREEN	DRAPER	ACCESSFITV	IMAGE AREA 8.5' X 5.3'
RX1	RECEIVER	EXTRON	DTP HDMI 4K 230 Rx	
SC1	CEILING SPEAKER	ATLAS SOUND	FAP63T	
SYSW1	SYSTEM SWITCHER	EXTRON	IN 1608 MA 70	
TTP1	TABLE TOP PANEL	EXTRON	CABLE CUBBY 500	WITH INSERTS
TTP2	TABLE TOP PANEL	EXTRON	CABLE CUBBY 202	
TX1	TRANSMITTER	EXTRON	DTP T DWP 4K 232 D	
TX2	TRANSMITTER	EXTRON	DTP HDMI 4K 230 Tx	
VD50	VIDEO DISPLAY	NEC	E505	CHIEF LSM1U MOUNT AND REQUIRED HARDWARE
VD70	VIDEO DISPLAY	NEC	E705	BMS CTAWA-LOCII AND REQUIRED HARDWARE
VPJ1	VIDEO PROJECTOR	CASIO	XT-UT310WN	BMS CTAWA-LOCII MOUNT AND REQUIRED HARDWARE
VPJ2	VIDEO PROJECTOR	CASIO	XJ-M246	BMS CTAWA-LOCII AND REQUIRED HARDWARE
WB	WIRELESS BELT-PACK	SHURE	UR1	
WLMC	PORTABLE CASE	PELICAN	1450	
WMR1	WIRELESS MIC RECEIVER	SHURE	ULSX4	

B. The above list of Major System Components only outlines the major items necessary to allow the system to function as designed. It lists no power supplies, balancing transformers, power splitters, modular cards or other auxiliary components required to achieve a functioning system. Contractor is required to supply all components needed to provide a complete and operable system as outlined in the contract documents. The full set of construction documents are to be used when preparing a bid. This list is not intended to provide a full bill of materials.

C. Patch bays shown on plans and elevations are for placeholder information only. Contractor is to determine the exact amount of patch needed as per single line diagrams.

2.3 FINISHES

A. Any item or component of the Work of this Section which is visible shall comply with the following. Finishes noted or scheduled on the Contract Drawings shall take precedence. Submit all color samples of all items visible to public for approval.
   1. Where finishes are not noted or otherwise defined in the Contract Documents, submit manufacturer's standard finish samples for selection by the Owner.
   2. Paint loudspeaker cabinets to match exactly the surrounding and adjacent surfaces. Submit paint sample to Owner's representative for approval.
   3. Unless otherwise noted, receptacle or device plates subject to connection or operating force shall be stainless steel or hard anodized aluminum. Provide plates which generally match the appearance of project standard receptacle or device plates in view in the same area. For anodized aluminum, submit samples of standard colors for selection by Owner.
   4. Operating panels shall be steel, primed, painted with thermosetting epoxy paint, with legends silk-screened in contrasting color, and coated with clear epoxy thermosetting coating; or aluminum, hard anodized, with legends engraved and filled with contrasting color, all coated with clear epoxy thermosetting coating.
   5. All steel surfaces shall be treated with primer equivalent to zinc phosphate and finish painted with baked enamel or painted with a thermo setting epoxy paint.
   6. All aluminum surfaces, except those used as operating surfaces, shall be anodized and then painted with a thermo setting epoxy paint.

B. Custom Fabricated Plate Screws
   1. Match the finish of the screws used to mount the custom fabricated plates with the finish of the custom fabricated plate.

C. Ceiling Loudspeaker Grilles
   1. Paint loudspeaker grilles to match exactly the surrounding and adjacent surfaces (when speakers are recessed). Apply paint to permit servicing of loudspeakers without damage to finish of adjacent or adjoining surfaces. Provide uniform appearance. Do not obstruct grille openings with paint. Submit paint sample to Owner's representative for approval.

D. Manufacturer's logos
   1. Remove all manufacturers' names, logos, or other symbols from speakers or other objects placed in view of the public.

2.4 ALTERNATIVES AND SUBSTITUTES

A. Substitutions of equal equipment beyond the alternatives listed will be permitted only in accordance with Division 1. If a requested substitution requires a change in any of the contract drawings, a revised drawing must be submitted as part of the substitution request. The Owner's Representative will be the final judge of the acceptability of substitutions. The burden of proof of equivalence is the responsibility of the Contractor.

B. Acceptance of a product shall not, in any form or manner, relax the system performance requirements of this Specification and the performance characteristics of the product.

C. The Contractor shall submit for review a complete list of proposed substitutions for approved equipment listed in Part 2.

D. For all substitutions, the Contractor shall provide the manufacturer's independent test data to demonstrate that the proposed alternatives to the approved equipment comply with the specifications. Specifications shall contain at least all information available for the specified product.

E. The Contractor shall submit a description and drawings showing all changes to the Contract Documents that the proposed substitution will require for proper functionality and operation.

F. Proposed substitutions shall not affect dimensions shown on the Contract Document except as submitted for review and approved by the Owner.

G. Any redesign or construction costs required to integrate the proposed substitution shall be the responsibility of the Contractor. Any costs incurred by the Owner, Owner's representatives, Architect, Engineers or Consultants attributable to the integration of a proposed substitution shall be borne by the Contractor.

H. Any proposed substitution shall have no adverse effect on other trades, the construction schedule or specified warranty requirements.

I. The functionality, performance, general appearance and quality of the proposed substitution are equivalent to or superior to those of the specified item.

J. Any change to the Contract (deductive or additive cost) associated with a proposed substitution shall be submitted to the Owner for review at the time the substitution is proposed and accompanying a substitution request documentation.

K. The Contractor will provide the same warranty for the substitution that the Contractor would for the specified product.

L. The Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects equal to the designed system before the substitution was made. In the event that the substituted material or equipment fails to meet performance testing standards after installed, the Contractor will replace substituted material or equipment with those initially specified.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform the Work of this Section in accordance with acknowledged industry and professional standards and practices, and the procedures specified herein.

B. Furnish and install (herein, "provide") all materials, devices, components, and equipment required for complete, operational systems.

C. Contractor is to supervise the installation of back boxes and terminal cabinets installed by the Division 26 Contractor. Contractor is to verify that correct boxes are installed in their proper locations before any drywall has been installed.

3.2 EXAMINATION

A. Immediately report to the Consultant any discrepancies between the specifications and drawings. This includes discrepancies between the technical specification documents and actual field dimensions or findings that may hinder installation work, conflict with other trades, or cause delays.

B. Carefully examine all details that affect all aspects of the systems described in the specifications and drawings.
   1. Examine, coordinate and confirm all drawings and details.
   2. Examine, coordinate and confirm all electrical power requirements, conduits, raceways, boxes, and etc.
   3. Examine, coordinate and confirm work of other trades that may influence the outcome of the design, specification, and performance of the systems.

3.3 PREPARATION

A. This installation section is only meant as a guideline for the Contractor. The Contractor shall be responsible for executing all installation work in a manner that is in accordance to industry-accepted standards or governing codes, whichever is more stringent. Installation activities shall be executed in an organized and orderly manner. These steps include, but are not limited to, pre-delivery testing, delivery, unloading, installation, equipment / cable labeling, programming, set-up / calibration / alignment / adjustment, testing, commissioning, training, and documentation.

B. Protect all existing work surfaces, furniture, equipment, fixtures and etc. before commencing installation work. Any damage to the existing physical and electrical property due to installation work shall be the responsibility of the Contractor.

C. Immediately hand over any de-installed equipment to the Owner for disposal or safe-keeping.

D. Carefully remove any obstructions such as fixed seating, ceiling tiles, furniture, equipment and etc. that would obstruct or hinder the installation work. Damage caused by undue care in moving these items shall be responsibility of the Contractor.

E. Examine, coordinate, and confirm the cleanliness of the work site before commencing the portion the installation work that involves dust-sensitive electronic or electrical equipment such as audio mixers, switchers, projectors, control processors, computers, cameras, etc. Dust-sensitive equipment that is installed in a work site with a lot of air borne dust and dirt shall be properly protected. For example, a video camera on a wall-mounted bracket is protected by a clean plastic bag to prevent dust from contaminating it. Seal the bag's opening using adhesive tape.

F. Prior to commencing installation work, ensure that the surrounding areas are clean and promote ease of installation work.

G. Ensure that all equipment rack and equipment locations are clean before commencing installation work.

H. Unless specified otherwise, furnished products / equipment shall be tested, delivered and installed. And, all systems shall be tested and commissioned to fully operational and properly configured condition.

I. All electrical equipment shall be burned-in or tested at the Contractor's shop before delivery. This pre-installation test shall reveal any equipment that is faulty, malfunctioning or dead out of the box ahead of time.

J. All radio frequency (RF) operated devices shall be tested on-site prior to installation to determine blind spots, RF interference, or any other transmission / reception problems. The Contractor shall be responsible for costs associated with providing additional support or accessory equipment (antennas, amplifiers, cables, etc.) and / or services to improve signal transmission / reception.

K. Provide all support equipment (ladders, man-lifts, tools, etc.) required to complete the installation work in a safe and expeditious manner.

L. Obtain any plan approvals, permits and licenses required by inspection authorities prior to execution of any installation work. The Contractor shall be responsible for all associated fees and costs incurred while fulfilling this requirement.

M. Ensure that all equipment is accessible for operation and maintenance work. Under no circumstance shall equipment be inaccessible or inconveniently located.

N. Aside from the systems' operational features, provide equal attention to the overall aesthetics of the installed equipment and cabling. Special attention to aesthetics shall be extended to equipment or cabling in public spaces.

O. Firmly secure all fixed equipment and hardware in place and ensure that they are plumb and / or square. An exception to this shall be portable or movable equipment.

P. Structurally mounted equipment: All equipment shall be mounted in accordance to all applicable safety codes, standards and practices. The one that provides for the most stringent rule shall prevail. All mounting hardware shall have a load rating by, at least, a factor of 5 (500% or greater) in reference to the weight of the equipment to be mounted or suspended. An exception to the rule shall be existing local safety codes or standards requiring greater load capacities.

Q. Seismic restraints: Abide by all the seismic restraint requirements described in all applicable building codes in force at the work site. If no provisions exist for a particular situation, follow these minimal recommendations.
   1. Fixed equipment: Mount and brace to the building structure to minimize potential hazards to personnel and damage to property during any kind of seismic event.
   2. Floor mounted equipment: Bolt equipment securely to the floor to prevent from toppling during any kind of seismic event
   3. Vertical-mounted columns: Apply braces to the vertical column in four opposing directions back to the mounting surface. This will minimize sway in any direction. Provide a separate, flexible restraint (e.g. aluminum braided aircraft cable) with a capacity of 5 times the weight of the total mounting system. The same applies to the anchor to which the flexible restraint is attached and the method of attachment to the structure.
   4. No equipment, equipment supports, or mounts must fail before the structure fails.
   5. Seismic restraint measure must not interfere with fire stopping.
   6. Notwithstanding compliance with these minimum recommendations, it is the Contractor's responsibility to ensure that the seismic restraint measures taken are adequate for the circumstances, including, if required, verification by an independent structural engineer. The cost of all such engineering shall be the responsibility of the Contractor.
   7. Penetration of the Slab: Verify that any mounting or restraint work that requires deep or thorough penetration of the slab shall not damage embedded materials including, but not limited to, slab tensioning devices or conduit. Verify the slab by X-ray or other method before proceeding. The Contractor shall be responsible for all costs associated with this investigation.

3.4 INSTALLATION

A. Follow manufacturer's instructions for installing, operating, configuring, and programming their equipment. Do not perform modifications to equipment that would void its warranty.

B. Pull and terminate all cables, and interconnect all equipment and components in accordance with approved drawings. Install audio-visual cover plates and faceplates onto all boxes.

C. Loudspeaker Assembly Installation
   1. Loudspeakers:
      a. Verify proper installation of loudspeaker enclosures and related support.

b. Verify that no loudspeaker assembly is subjected to stresses or loading effects in any way contributing to possible extraordinary failure.
c. Connect loudspeaker assemblies to the appropriate 70 volt-line transformer tap as applies. Verify specified polarity. Use insulated crimp connectors or insulated "bobtail" splices applied with manufacturer's recommended ratchet tooling. Wago Wall-Nuts 773 Series or equal are acceptable. Wire nuts or "Scotchlock" connectors shall not be acceptable.
d. Verify that loudspeaker grille openings and loudspeaker components are clear of paint after finishing.
e. Perform preliminary loudspeaker tests specified herein. Correct non-conforming conditions.
f. Adjust 70 volt-line transformer taps as required to realize uniform sound pressure level as specified herein. Document final 70 volt-line transformer taps on the Record Drawings.
g. Correct all conditions giving rise to noise, rattle or other extraneous sounds owing to operation of a loudspeaker assembly under any specified operating condition.

D. Video Projectors
1. Projectors shall be centered laterally to the projection screens.
2. Projectors shall be mounted such that digital keystone compensation shall not be required.
3. Selected projectors shall have lamp replacement and filter cleaning doors located in such a way that these items may be serviced while the projector is installed.
4. Projectors shall be mounted such that their optical zoom settings shall not be set at either their widest nor narrowest extreme, but shall be used in their mid-range.

3.5 LABELING AND IDENTIFICATION

A. All cables and connecting blocks shall be clearly, logically and permanently marked and identified by the following means:
1. Use cable labels similar to the Panduit Polyolefin Self-laminating Labels for inkjet or laserjet printers or any other means acceptable to the Consultant. Cable labels should be machine printed and not handwritten.
2. Cable labels should be placed approximately 12 cm. from each end of the cable.
3. Labeling conventions shall be clear, logical, and must be acceptable to the Consultant.
4. Include all cable identification numbers on all wiring diagrams and cable schedules.
5. For fiber optic cables, use cable identification products such as the Panduit Labelcore series or any other means acceptable to the Consultant.
6. For connector and terminal blocks, label using any means acceptable to the Consultant.

B. All cover plate, switches, panels, outlets, etc. labeling shall be engraved and filled, or silk-screened or by any other means acceptable to the Consultant. Do not use Dymo, Brother, or other similar labeling products.

C. Protective Devices
1. Identification of fuses and circuit breakers shall indicate protected circuitry, rating of protective device and voltage across open circuited protected device.

D. Panels and Receptacles
1. Panel surfaces shall be engraved and filled or silk screened with identification, or shall be provided with 1/16 inch (minimum) thick laminated plastic labels with engraved block characters at least 1/8 inch high fastened to the equipment by stainless steel screws or rivets. Provide white characters on black background unless otherwise noted. Embossed plastic (Dymo) labels shall not be acceptable.

E. All equipment shall be labeled in a clear, logical manner or by any other means acceptable to the Consultant.

1. For Control Knobs and Sliders: Use 6mm (1/4") round labels, such as the Avery 057xx series, to indicate level settings. Neatly draw an arrow on the label using a fine tip permanent marker to accurately indicate the position of the control knob. If a control knob or slider has multiple level settings, use a logical and consistent color scheme to identify each setting. Illustrate all equipment settings in the Operation Manual.
2. For equipment identification, use 'badges' made of aluminum or plastic or any other acceptable material with engraved and filled, or silk-screened labeling. Stick these badges using industrial-strength doubled-sided 3M adhesive tape. Note: Label schemes should be clear, logical, and simple or by any other means acceptable to the Consultant. Indicate equipment labeling schemes on all elevation and plan drawings showing the front and / or rear of the equipment racks. The reader should be able to easily reference the label description to specific equipment in the Operation and / or Maintenance Manuals.

3.6 WIRING

A. General
   1. This section does not apply if the drawings incorporate a wire schedule.

B. Audio Signal Wiring Classification:
   1. Type A-I: Microphone level wiring less than -30 dBu, 20 Hz to 20 kHz.
   2. Type A-2: Line level wiring -30 dBu to +24 dBu, 20 Hz to 20 kHz.
   3. Type A-3: Loudspeaker level or circuit wiring greater than +24 dBu, from 20 Hz to 20 kHz.

C. Video/Graphics and Related Signal Wiring Classification:
   1. Type V-1: Baseband and composite video wiring 1 volt peak-to-peak into 75 ohms, 0 to 100.0 MHz.
   2. Type V-2: Synchronization and switching pulse wiring 4 volts peak-to-peak into 75 ohms, 15.62 to 15.75 kHz.
   3. Type V-3: Color subcarrier wiring 0 to 4 volts peak-to-peak into 75 ohms, 3.57 to 4.43 MHz.

D. Control Signal Wiring Classifications:
   1. Type C-1: DC control wiring 0 to 50 volts.
   2. Type C-2: Synchronous control or data wiring 0 to 40 volts, peak-to-peak.
   3. Type C-3: AC control wiring 0 to 48 volts, 60 Hz.

E. Additional Wiring Classifications:
   1. Type M-1: DC power wiring 0 to 48 volts.
   2. Type M-2: AC power wiring greater than 50 volts, 60 Hz.

F. Wiring Combinations: Except as indicated herein, conduit, wire ways and cable bundles shall contain only wiring of a single classification. The following combinations are acceptable in conduit, or cable harnesses. Additional acceptable combinations may be indicated on the Contract Drawings.
   1. Types A-1, C-1, and M-1.
   2. Types A-2, C-I, C-2, and M-I, runs less than 20 feet.
   3. Types A-2, C-1, and M-1.
   4. Types A-3, C-1, C-2, and M-1.
   5. Types A-2, V-1, and V-3.
   6. Types V-1, V-2, V-3, and C-1.
   7. Types M-2 and C-3.

3.7 WIRE AND CABLE INSTALLATION

A. Provide permanent identification of run destination at all raceway terminations.

B. All wire and cable shall be continuous and splice-free for the entire length of run between designated connections or terminations.

C. All shielded cables shall be insulated. Do not permit shields to contact conduit, raceway, boxes, panels, connector shell or equipment enclosures.

D. Within buildings, make splices only in designated terminal cabinets and/or on designated equipment backboards. Outside buildings, make splices only in designated manholes and/or hand holes. Protect splices outside of buildings with splicing kits equivalent to Scotch-cast Re-enterable. Make splices only with connectors or terminal devices specified herein. Document all splices on Record Drawings.

E. Verify that all raceway has been de-burred and properly joined, coupled, and terminated prior to installation of cables. Verify that all raceway is clear of foreign matter and substances prior to installation of wire or cable.

F. Inspect all conduit bends to verify proper radius. Comply with Code for minimum permissible radius and maximum permissible deformation.

G. Apply a chemically inert lubricant to all wire and cable prior to pulling in conduit. Do not subject wire and cable to tension greater than that recommended by the manufacturer. Use multi-spool rollers where cable is pulled in place around bends. Do not pull reverse bends.

H. Provide a box loop for all wire and cable routed through junction boxes or distribution panels. Provide tool formed thermal expansion loops at cable at manholes, handholes and at both sides of all fixed mounted equipment. Cable loops and bends shall not be bent at a radius greater than that recommended by the manufacturer.

I. Secure all wire and cable run vertically for continuous distances greater than 30 feet. Secure robust non-coaxial cables with screw-flange nylon cable ties or similar approved devices appropriate to weight of cable. For all other cables, provide symmetrical conforming nonmetallic bushings or woven cable grips appropriate to weight of cable.

J. All Category type cable, connectors and plugs shall be color coded for easy visual distinction. Color coded insert type boots shall be installed on all Category type plugs. A colored coded ring will be provided on all chassis connectors (i.e. Neutrik ACRF-#). Cable connecters shall be equipped with Neutrik BSE-# color coded bushings. The Color code shall be as follows:
   1. Digital Video / AV UTP =Green
   2. LAN =Yellow
   3. Audio Network =Red
   4. AV Local Area Network =Orange
   5. Digital Media =Blue
   6. Computer Training KVM =Grey
   7. AV UTP =White

3.8 CONNECTOR AND SIGNAL POLARITY CONVENTION

A. Maintain consistent absolute signal polarity at all connectors, patch points and connection points accessible in the system. Where applicable, a positive polarity electrical signal shall yield positive acoustic pressure from the loudspeakers.

B. Audio signal connector convention: AES14-1992 (ANSI S4.48-1992) AES standard for professional audio equipment - Application of connectors, Part 1, XLR-type polarity and gender.

Signal	Connector	Wire
Signal Phase	Pin 2	Red or White
Signal Anti-Phase	Pin 3	Black
Signal Ground	Pin 1	Drain Wire

C. Video and RF/MATV Connector Convention:

Signal	Connector	Wire
Signal Phase	Center Pin	Center conductor
Signal Anti-Phase	Shell	Shield
Signal Ground	Shell	Shield

D. Voice/Data Connector Convention: Comply with EIA/TIA-568C.

3.9 WIRING PRACTICE

A. Land all non-coaxial field wiring entering each equipment rack at specified terminal devices prior to connection to any equipment or devices within racks. At Contractor's option, such terminals may be located in the equipment racks or at backboards provided. Coordinate such selection with Project construction sequence and test procedures specified herein.

B. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one inch of each connection. Indicate the number designated on the associated field or shop drawing or run sheet, as applies. Assign wire or cable designations consistently throughout a given system. Each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Provide any of the following:
   1. Continuous permanent imprint; equivalent to Clifford of Vermont, Inc. "Quik-Pull".
   2. Direct hot stamp.
   3. Heat shrinkable factory hot stamped; equivalent to Brady sleeve Heat shrink.
   4. Adhesive strip printed labels wrapped the full circumference of the wire and sealed with clear heat shrink tubing; equivalent to Thomas and Betts or Panduit Insta-code with clear heat-shrunk tubing equivalent to Alpha.

C. Apply all crimp connectors only with manufacturer's recommended ratchet type tooling and correct crimp dies for connector and wire size. Plier type crimp tooling shall not be acceptable.

D. Coordinate insulation displacement (quick connect) terminal devices with wire size and type. Comply with manufacturer's recommendations. Make connections with automatic impact type tooling set to recommended force.

E. Make all connections to screw-type barrier blocks with insulated crimp-type spade lugs. Lugs are not required at captive compression terminal type blocks. Provide permanent designation strips designed for use with the terminal blocks provided. Make neat, intelligible markings with indelible markers equivalent to "Sharpie".

F. Tin terminated shield drain wires and insulate with heat shrinkable tubing.

G. Use only rosin core 60/40 tin/lead solder for all solder connections.

H. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections. No wire or cable shall be supported by a connection point. Provide service loops where harnesses of different classes cross, or where hinged panels are to be interconnected.

I. Termination and build out resistors and related circuit correction components shall be visible. Do not install in connector shells or internally modify equipment. Show locations on Record Drawings.

J. Correct any and all of the following unacceptable wiring conditions:
   1. Deformed, brittle or cracked insulation.
   2. Insulation shrunken or stripped further than 1/8-inch away from the actual point of connection within a connector, or on a punch block.

3. Cold solder joints.
4. Flux joints.
5. Solder splatter.
6. Non-grommet, non-bushed, or non-insulated wire or cable entries.
7. Deformation or improper radius of wire or cable

3.10 SIGNAL GROUNDING PROCEDURES

A. Comply with National Electrical Code.

B. Unless otherwise noted maintain a unipoint ground scheme.

C. Signal and electrical system grounds shall be isolated except at the Project ground field connection.

D. Equipment enclosures shall not be permitted to touch each other unless bolted together and electrically bonded.

E. Ground and bond equipment racks and similar equipment enclosures containing powered equipment exclusively via the Isolated Ground conductors provided under Division 26. INSULATE RACK MOUNTING, ANCHORAGE, AND RACEWAY CONNECTIONS.

F. At each rack, provide an Isolated Ground bus within the rack. At each rack, provide a lug bonded to the rack frame with a #8 TW stranded wire to the rack Isolated Ground bus.

G. At each ensemble of racks, provide a single labeled Isolated Ground tubular-clamp bus bar terminal strip to land the individual rack Isolated Ground bus ground conductors. Connect the main Isolated Ground conductor from the Technical Power panel board at this point.

H. Equipment signal ground shall be to the Isolated Ground System via the green wire of the equipment power cord. Where equipment uses two wire power cord, provide #12 green bond wire to rack IG bus bar. At equipment, provide crimp lug and suitable hardware for bonding.

I. Shielded cables of this section shall be grounded exclusively to Isolated Ground by a single path. Shield shall be tied to Isolated Ground at one end only, i.e., at the low potential (receiving) end of run, unless otherwise noted.

J. Unless otherwise noted, at audio jackfields, tie source shield at jackbay frame. Float shields at connections to output jacks. Bus each row of jack frames and run individual #12 green ground wire for each row to rack IG bus bar.

K. Signal Ground provisions shall realize less than 0.15 ohms to the primary ground connection.

3.11 EQUIPMENT ENCLOSURE (RACK) AND EQUIPMENT BACKBOARD FABRICATION

A. Combustible material, other than incidental trim of indicated equipment, is prohibited within equipment racks.

B. Within each equipment enclosure, provide a full-height multi-circuit ISOLATED GROUND outlet strip with branch circuit count as shown on drawings; locate on the left side of the equipment enclosure, as viewed from the rear. In each enclosure provide number of receptacles required by present and future equipment indicated on drawings, plus at least two spare receptacles. Provide flexible steel raceway and junction box for connection of power service. Bond internal raceway to rack frame.

C. Provide a permanent label on the front of each equipment rack including the rack designation, and the circuit breaker number and associated electrical distribution panel designation servicing same.

D. Maintain separation of wiring classifications as specified herein. Separately dress, route and land microphone and line level cables and related on the right side of the equipment enclosure, as viewed from the rear; dress, route, and land loudspeaker level and control cables on the left side of the equipment enclosure, as viewed from the rear.

E. Access shall not require demounting or de-energizing of equipment. Install access covers, hinged panels, or pull-out drawers to insure complete access to terminals and interior components.

F. Fasten removable covers containing any wired component with a continuous hinge along one side, with associated wiring secured and dressed to provide an adequate service loop. Provide an appropriate stop locks to hold all hinged panels and drawers in a serviceable position.

G. Provide permanent labels for all equipment and devices. Where possible, fasten such labels to the rack frame or to blank or vent panels which will remain in place when active equipment is removed for possible service.

H. At jackfields, provide service loop to permit removal of jackfields from rack sufficient to conveniently access all jack contacts for routine cleaning and maintenance. Organize the service loop and harness such that reasonable reconnection of jacks and jack normals is possible without cutting apart the harness.

I. Coordinate the design and execution of wire harnessing of multi-bay rack ensembles with conditions of delivery to installation locations at Project Site, and with the requirement herein for test of the completely wired system in the shop prior to delivery to the Project Site. Organize the wiring harnesses such that they will fold within one shippable unit without risk of damage, or provide polarized multipin connectors and related interconnect systems as specified elsewhere herein.

J. At each equipment backboard, provide UL Listed surge suppressing multi-outlet assembly with at least six receptacles.

3.12 ADJUSTING AND TESTING

A. Test Equipment
   1. Furnish, store and maintain test equipment at the fabrication shop and the job site for both routine and Acceptance Testing of the Work of this Section. Maintain all test equipment at the job site while work is in progress from installation of equipment racks until Owner Acceptance of this Work; thereafter remove all of this test equipment from the job site. Provide all required test cables, jigs and adapters. Provide at least one of the following items or approved functional equivalents:
   2. Audio Systems:
      a. Wide Band Oscilloscope (Tektronix THS700 Series).
      b. True RMS Analog / Digital Volt-Ohm Multimeter (Fluke 187 Series or equal).
      c. Low Distortion Audio Frequency Sine Wave Oscillator (Gold Line TS1).
      d. Measurement Microphones (Earthworks M30, Bruel & Kjaer 4007, Josephson 550).
      e. Sound System Optimization and Acoustic Measurement Analyzer (Goldline TEF, Meyers SIM, SIA Smaart, WinMLS, EASERA).
      f. Harmonic Distortion Analyzer (Sound Technology or Tektronix AA 501A) or Swept Spectrum Analyzer, HP 3580A, or Swept Test System, Audio Precision or Neutrik).
   3. Video Systems:
      a. Wide Band Oscilloscope (Tektronix THS700 Series).
      b. Sync & Test Generator (Tektronix 1470).
      c. Waveform/Vector Monitor (Tektronix 1740).
      d. Color Picture Monitor, Precision.
   4. Communications and Related:
      a. Level II, Cat5e Cable Pair Tester (Microtest, HP, Scope, Fluke or Siemons set up to meet Category 5e parameters).

b. Outside Plant Voice Cabling Plant Tester – capable of detecting shorts, opens, reversals, mis-wiring and crosstwists (Siemon STM-8 or equal by Mod-Tap).
c. Metallic cable pair tester (Wavetek Corporation, Instruments Division, model LANTech 100).
d. Tone Test Set.
e. Optical Time Domain Reflectometer (OTDR) for fiber optics.
f. Any other items of equipment or materials required to demonstrate conformance with the Contract Documents.

B. System Performance Testing and Adjusting Procedures
1. Upon completion of the installation of all equipment in an area, perform the following tests and record results. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report. Correct all non-conforming conditions prior to requesting Acceptance Review and Testing. Perform at least the following procedures:
2. Mechanical: Verify:
   a. Integrity of all support provisions.
   b. Absence of debris of any kind, tools, etc.
3. Power and Isolated Ground: Verify:
   a. Isolation of Isolated Ground system from raceway and related ground.
   b. Grounding of devices and equipment. Integrity of signal and technical power system ground connections.
   c. Proper provision of power to devices and equipment.
4. Signal Wiring: Verify:
   a. Integrity of all insulation, shield terminations and connections.
   b. Integrity of soldered connections. Absence of solder splatter, solder bridges.
   c. Routing and dressing of wire and cable.
   d. Continuity, including conformance with wire designations on running sheets, field and shop drawings.
   e. Absence of ground faults.
   f. Polarity.
5. Use the proper sequence of energizing systems to minimize the risk of damage.
6. Audio Systems:
   a. Electronic Tests; confirm:
      1) Gain at 1 kHz.
      2) Maximum output.
      3) Input clipping level.
      4) Frequency response.
      5) Total harmonic distortion.
      6) Signal-to-Noise ratio.
      7) Signal-to-Crosstalk ratio.
   b. Electro/Acoustic Tests:
      1) Uniformity of coverage.
      2) Electronic and acoustic frequency response/one-third octave equalization. Transfer function measurement shall be as close to flat as possible. Measure at ear level. Representative of the Owner will direct final adjustment.
      3) Maximum continuous sound pressure level (in the reverberant field). Drive systems with broadband pink noise. Sustain for at least five minutes with no system damage. Measure for "A" and "C" weightings at ear level on loudspeaker axis. Turn off noise.
      4) Acoustic signal-to-noise ratio referenced to the specified maximum continuous sound pressure level in the reverberant field. Measure for "A" and "C" weightings at ear level on loudspeaker axis with mechanical systems operating. Present comparison with previous measurement.

5) Acoustic gain before feedback. Locate acoustic source (4 inch loudspeaker/pink noise generator) two feet from system microphone. Measure at system microphone position and at most distant listener position at ear level. Present comparison.

7. Video Systems:
   a. Video Monitors:
      1) Apply crosshatch. Verify linearity.
      2) Apply red field. Adjust purity.
      3) Apply SMPTE bars and PLUGE. Adjust to standards.
   b. Video Path Test: Use NTC-7 procedures. Use full field or line signals. Alternately, conduct copper time domain reflectometer test.
8. Fiber System:
   a. Fiber:
      1) Conduct optical loss test.
      2) Conduct optical time domain reflectometer test.
9. Diagnostic Monitoring System:
   a. Demonstrate complete operation.
10. System Overall:
    a. Verify levels.
    b. Provide permanent "wedge" type labels on all controls, as applies, to indicate correct settings after systems performance testing and adjustment procedures have been successfully completed.

C. Loudspeaker Assembly Testing and Adjusting Procedures
   1. Upon completion of the installation of all loudspeakers in an area, perform the following tests and record results. Correct non-conforming conditions, unless the cause is clearly outside the Work of this Section, in which case submit the apparent cause to the Owner.
   2. Loudspeaker Line Impedance: At terminal cabinets at equipment rooms, measure the impedance of each loudspeaker line. Sweep from at least 20 Hz to at least 16 kHz.
   3. Loudspeaker Polarity: Test the acoustic polarity of all loudspeakers using an Acoustic Polarity Tester.
   4. Freedom From Buzzes, Rattles and Objectionable Distortion: Individually apply to each loudspeaker line a slow sine wave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power amplifier output voltage. Listen carefully for buzzes, rattles and objectionable distortion.
   5. Uniformity of Coverage: Apply broadband Pink Noise. Adjust level to approximately 70-80 dBA at measurement locations. Measure in 4 kHz octave band at ear level. Adjust loudspeaker aiming and 70 Volt loudspeaker taps for uniformity of coverage.

D. Equipment Rack and Equipment Testing and Adjusting Procedures
   1. Conduct procedures in fabrication shop. Verify safe and proper operation of all components, devices, or equipment, establish nominal signal levels within the systems and verify the absence of extraneous or degrading signals. Make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system interconnection points, gains and losses, as applicable. Submit test report with color photographs of each equipment rack, front and back. Request and coordinate verification of submitted test data by the representative of the Owner. Correct all non-conforming conditions prior to shipment to Project Site. Perform at least the following procedures:
   2. Preliminary: Verify:
      a. Grounding of devices and equipment. Integrity of signal and electrical system ground connections.
      b. Proper provision of power to devices and equipment.
      c. Integrity of all insulation, shield terminations and connections.
      d. Integrity of soldered connections. Absence of solder splatter, solder bridges.
      e. Absence of debris of any kind, tools, etc.
      f. Routing and dressing of wire and cable.
      g. All wiring, including polarity and continuity, including conformance with wire designations on running sheets, field and shop drawings.

h. Mechanical integrity of all support provisions.
3. Rig temporary power and grounding: Comply with all applicable Codes, regulations and ordinances.
4. Determine the proper sequence of energizing systems to minimize the risk of damage. Energize. Burn in for at least 120 hours.

E. Telecommunications Cabling Testing
1. Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.
2. Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3. Visually confirm Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.
3. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connected.
4. For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568- C.3 and TIA-526-14-A using Method A, Optical Power Meter and Light Source for multimode optical fiber. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568- C.3 and TIA-526-7 using Method A, Optical Power Meter and Light Source]. Perform verification acceptance tests.
5. Perform testing for each outlet as follows:
   a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA/EIA-568-B.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
   b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3. E. Final Verification Tests
   c. Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

3.13 CLEANING

A. Clean each section or area of where the work was conducted after completion to permit immediate use of the area. Remove and discard all refuse, rubbish, and debris.

B. The Contractor shall ensure that all recyclable and environmentally-hazardous waste materials are disposed properly.

C. Make good all existing structures, surfaces, and utilities affected by cutting, coring, mounting, drilling, or other new work.

D. Clean all furnished equipment of dust, dirt, finger prints, smudge, and other material prior to calling for a Substantial Performance of Work Review or Completion of Work Review.

3.14 PROTECTION

A. During the installation phase and up to the date of achieving Substantial Performance of Work, protect finished or unfinished work against damage or loss. In the event of such damage or loss, immediately replace or repair such work or equipment at no cost to the Owner.

3.15 ACCEPTANCE REVIEW, TESTING PROCEDURES AND COMMISSIONING

A. Complete all Work of this Section. Submit Test Report. Submit review copies of Operating and Maintenance Manuals, less reduced set of Record Drawings. Notify the Owner in writing that the Work of this Section is complete and fully complies with the Contract Documents. Request Acceptance Review and Testing by returning Attachment “A” to the Design Consultant. The representative of the Owner will conduct Verification of Submitted Test Data, and otherwise direct testing and adjustment of this Work. These Procedures may be performed at any hour of the day or night as required by the representative of the Owner to comply with the Project Schedule and avoid conflict with these procedures from possible ongoing work of other Separate Contracts and/or the Owner's operations. Provide all specified personnel and equipment at any time without claim for additional cost or time.

B. Personnel: Provide services of the designated supervisor and additional technicians familiar with work of this Section. Provide quantity of technicians as required to comply with Project Schedule.

C. In Addition, Provide:
   1. Set of hand and power tools appropriate for performance of adjustment of and corrections to this Work.
   2. Include spare wire and connectors and specified tooling for application.
   3. Ladders, scaffolding and/or lifts as required to access loudspeakers and other high devices.
   4. Test equipment to include but not limited to:
      a. Dual channel FFT-based audio analyzer
      b. Video test generator with color bars, grayscale, alternating pixel, multi-burst, crosshatch and % windows.
      c. InfoComm Projection Shoot-Out DVD
      d. Digital Video Essential Professional DVD
      e. Category cable tester, cable length, short, open and miswire test.
   5. Complete set of latest stamped, actioned submittals of record for reference.
   6. Complete set of Shop and Project Site Test Reports.
   7. Complete set of manufacturer's original operation, instruction and service manuals for each equipment item for reference.

D. Demonstrate: Complete operation of all systems and equipment, including Portable Equipment.
   1. General
      a. Configure room for each type of event and demonstrate audio-visual system.
      b. Connection of portable equipment. (Laptop, document camera, etc.)
      c. Demonstrate to the Consultant that all functions and equipment for the system work properly when installed as a complete system.
      d. The Contractor shall demonstrate the satisfactory operation of all controls and adjustment circuits of the system.
      e. Demo room scheduling software where applicable.
      f. Room combining and dividing presets.
      g. Demonstrate system startup and shut down procedures.
   2. Audio
      a. Route audio to program speakers.
      b. Route audio to monitor speakers.
      c. Patch each audio tie line into system.
      d. Route audio signal to auxiliary speakers.
      e. Connect microphone to each panel input and route through system.
      f. Demonstrate and document gain structure through the system.
      g. Demonstrate and document with a dual channel FFT-based audio meter the following:
         1) Polarity of each driver in each cabinet.
         2) Crossover point of high, mid and low section of each loudspeaker.
         3) dB SPL levels from 1-4 kHz at various position in the audience area.
         4) dB SPL level of high, mid, low and sub frequency bandwidth at crossover.
      h. Audio routed to ceiling speakers.
      i. Audio Conferencing.

j. Wireless microphones.
k. Demonstrate that the audio system is properly time aligned and equalized.
l. Assistive listening system.
m. Production intercom system.

3. Video
   a. Route source equipment (Blu-ray Player, TV tuner, test generators, etc.) to video displays and projectors.
   b. Set up rooms for each type of event that may take place and demo each.
   c. Recording of a distance learning session.
4. Control
   a. Communication between control system and AV equipment, including feedback if device supports 2-way communication
   b. User interface operation.
   c. Password protection of user interface.
   d. Help desk features.
   e. All programmed presets.
   f. Lighting and window shade control.
5. The Contractor 's personnel and test equipment shall be made available to the Consultant in order that:
   a. Selected tests and measurements previously made by the Contractor can re-run.
   b. Other tests may be made at Consultant's discretion.
   c. Additional tests or measurements may be made due to changes in field conditions.
6. It is estimated that the acceptance tests and demonstrations will require approximately *four hours*, unless construction or installation problems or deviations from the specifications are discovered.

E. Adjust: As directed by the representative of the Owner.

F. Correct: In timely manner, failure to comply with the Contract Documents, as reasonably determined by the representative of the Owner.

G. Acceptance Documentation
   1. Official acceptance of the system covered by this specification will occur when the Design-Builder receives the following written documents:
      a. A letter from the Consultant to the Architect acknowledging Final Acceptance of the system stating compliance with all articles of the specifications.
      b. A letter from the Architect to the Contractor stating that all related work has been completed to his satisfaction. Until these documents are received, the installation is not formally complete. The official date of acceptance shall be the date of the letter from the Architect to the Contractor described above.

3.16 CLOSEOUT

A. Punch List: Perform any and all remedial work, at no claim for additional cost or time. Where required, retest and submit Test Report. Notify Owner of completion of Punch List.

B. Portable Equipment: Furnish all portable equipment and spares to the designated representative of the Owner, along with complete documentation of the materials presented. Where applicable, furnish portable equipment in the original manufacturer's packing.

C. Operating and Maintenance Data: Install framed operating and maintenance instructions. Submit Manuals.

D. Project Record Documents: Submit.

E. Keys: If applicable, replace construction locks with permanent locks. Transmit keys to Owner.

F. Training: Conduct specified training and submit training manuals.

G. Warranty: Submit Warranty dated to run from date of Acceptance of the Work of this Section.

3.17 OWNER'S RIGHT TO USE EQUIPMENT

A. Acceptance of the Work of this Section will be after completion of corrections and adjustments required by the "Punch List" which results from Acceptance Review and Testing of the completed installation. The Owner reserves the right to use equipment, material and services provided as part of the Work of this Section prior to Acceptance without incurring any obligation to Accept any equipment or completed systems until all Punch List work is complete and all systems comply with the Contract Documents; or accept any claim for additional cost or time.

Attachment "A"

NOTICE OF COMPLETION
&
REQUEST FOR FINAL INSPECTION

We hereby give notice that the work associated with the Audio-Visual system, at the project named below, is completed and fully complies with the contract documents issued to the Contractor. The required submittals below have been marked as completed.

- ☐ Programming
- ☐ Test Reports
- ☐ Operation Manual
- ☐ Maintenance Manual
- ☐ Training Manual
- ☐ Training
- ☐ Warranty Certificates
- ☐ Record Drawings

We request commissioning and verification testing be scheduled with the Owner's Representative for final system sign off. Attached is a list of test equipment for review and acceptance.

PROJECT INFORMATION

Project Name:	Project Phase:
Project Address:	

CONTRACTOR INFORMATION

Name:	Company:	
Address:		
Signature:		Date:

Note to Contractor: Provide all test equipment for final inspection as described in the specification.

Please complete and fax or email this form to Veneklasen Associates attention AV Department
Fax (310) 396-3424 Email dyoung@veneklasen.com

END OF SECTION

SECTION 275313
CLOCK SYSTEM

PART 1 GENERAL

1.1 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.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit Product Data Sheets and Descriptive Literature for all Component Parts.

B. Submit Block Wiring Diagram of the Clock and Paging systems. Showing headend equipment, terminal cabinets, remote power supplies, and typical clock for each zone.

1.3 EQUIPMENT QUALIFICATION

A. The Specification is based on the Equipment of Manufacturers who has been approved by the District and the Manufacturers herein named shall be considered as meeting the requirements of this Specification. For all items which are identified by part number and Manufacturer the Performance Specifications which are published in the most recent Manufacturer's data sheets available at the time of bidding this Project shall be applicable to the present work as though fully written out herein.

B. All Equipment shall conform to all local applicable Codes and Ordinances, and shall be listed by Underwriters Laboratories.

1.4 QUALIFICATIONS

A. To qualify as an Acceptable Bidder, whether the bid is submitted to the District, his Agent, a General Contractor or a Sub-Contractor, the System Bidder or Contractor shall be Qualified Sound Contractor and shall hold a valid C61 License issued by the Contractors State License Board of California. The System Bidder or Contractor shall hereinafter be referred to as the Contractor. The Contractor shall hold all other licenses required by the legally constituted Authorities Having Jurisdiction over the work. The Contractor shall be the Factory Authorized Distributor for the brand of equipment offered and shall have been engaged in the business of supplying and installing the specified type of system for at least 5-years. The Contractor shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment.

1.5 GENERAL REQUIREMENTS AND SCOPE

A. Furnish and Install a complete new GPS Wireless Clock System using Primex Wireless Inc. GPS Wireless system or equal by American Time and Signal, Sapling. All bids shall be based on the equipment as specified herein.

B. Section includes Transmission Systems GPS Receiver, Primary Transmitter, and Satellite Transmitter.

1. Clocks:
   a. Analog
   b. Digital

1.6 RELATED SECTIONS

A. Division 26 – Electrical (120 volt grounded outlet required for transmitter).

1.7 REFERENCES

A. This Technical Specification and Associated Drawings, Primex Wireless GPS Satellite Time System User Manual.

1.8 DEFINITIONS

A. GPS: Global Positioning System, a worldwide system that employs twenty-four satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world's most accurate and reliable time.

1.9 SYSTEM DESCRIPTION

A. GPS Wireless Clock System shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.

B. The System shall provide wireless time using GPS and be synchronized to UTC. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Saving Time

C. Analog Clocks shall be synchronized to within 10-milliseconds 6-times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.

D. The System shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.

E. The System shall incorporate a "Fail-Safe" design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal Operation without the need to reset the system or any component thereof.

F. Clock Locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

G. The System must operate in accordance with a "Radio Station Authorization", Form FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.10 REGULATORY REQUIREMENTS

A. Equipment and Components Furnished shall be of Manufacturer's latest model.

B. The End User Will Hold a License, known as a "Radio Station Authorization" granted by the FCC.
   1. This license grants the end user protected use for wireless transmission at the designated frequency.
   2. This license will designate a unique "call sign" for each end user.

C. Transmitter and Receiver shall comply with Part 90 of FCC rules as follows:
   1. This device may not cause harmful interference, and
   2. This device must accept interference received, including interference that may cause undesired operation.
   3. Transmitter frequency shall be governed by FCC Part 90.35.
   4. Transmitter output power shall be governed by FCC Part 90 257 (b)

D. System shall be installed in compliance with Local and State Authorities Having Jurisdiction.

E. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the

District/End User prior to operating the equipment. The original license must be delivered to the District/End User.

F. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

G. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

H. Floor Plans indicating the location of system transmitter(s), approved by Manufacturer, will be submitted to District prior to installation.

1.11 QUALITY ASSURANCE

A. Permits: Obtain Operating License for the Transmitter from the FCC.
   1. Qualifications:
      a. Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including 4 years' experience producing GPS wireless time systems.
      b. Installer: Company with documented experience in the installation of commercial time systems.
   2. Prior to installation, a site survey must be performed to determine proper transmitter placement.

1.12 DELIVERY STORAGE AND HANDLING

A. Deliver all Components to the Site in the Manufacturer's original packaging. Packaging shall contain Manufacturer's name and address, product identification number, and other related information.

B. Store Equipment in finished building, unopened containers until ready for installation.

1.13 PROJECT SITE CONDITIONS

Clocks shall not be installed until painting and other finish work in each room is complete. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.14 SYSTEM STARTUP

At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

1.15 WARRANTY

Manufacturer will provide a 1-year warranty on GPS receiver, transmitter, and satellite transmitter. All other components will have a 1-year warranty.

Part 2 PRODUCTS

2.1 MANUFACTURER

A. GPS Wireless Clock System shall be manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva WI 53147, telephone (800) 537-0464, Fax (262) 248-0061, www.primexwireless.com or equal by American Time and Signal, Sapling.

2.2 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once

every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Analog Clock Operation:
   1. Apply power or insert batteries. Follow set up procedures detailed in Manufacturer's instructions.
   2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
   3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.3 EQUIPMENT

A. General: The Clock System shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.

B. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.

C. The GPS Receiver cable must be plenum rated where required by local code.

D. Transmitter: Primex Wireless Model 14400, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.
   1. Transmission:
      a. Frequency Range: 72.100 to 72.400 MHz.
      b. Transmission Power: 1 watt (30dBm) maximum
      c. Radio technology: narrow band FM
      d. Number of channels: 16
      e. Channel bandwidth: 20kHz maximum
      f. Transition mode: one-way communication
      g. Data rate: 2 KBps
      h. Operating range: 32 degree F to 158 degrees F (0 degrees C. to 70 degrees C).
   2. Transmitter:
      a. Transmitter output power: +26 to +30 dBm
      b. Frequency deviation: +/- 4 kHz
      c. Transmitter power requirements: 120 VAC 60 Hz
      d. Internal power requirements: 5 VDC
      e. Carrier frequency stability: +/- 20 ppm
   3. Transmitter shall have 16 selectable channels to assure interference-free reception.
   4. Transmitter shall have the following switches:
      a. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.
      b. Daylight Saving Time bypass switch.
      c. 12-hours or 24-hours display.
   5. Transmitter housing shall be black metal case, 16-3/4 inches (424.4mm) by 12 inches (304.8mm) by 1-7/8 inches (46.4mm) in size.
   6. Antenna shall be 46-inches (1168mm) high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.
   7. Transmitter housing shall incorporate a display which shall include the following:
      a. Time readout
      b. AM and PM indicator if 12-hour time display is set
      c. Day and date readout
      d. Indicator for daylight savings or standard time
      e. LED which shall flash red in event of reception problem
      f. GPS reception indicator

8. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.
9. Power supply (included):
   Input: 120 volt AC 50/60 Hz, 0.4 amps.
   Output: 9 volt DC, 1.5 amps.

E. Surge Protector/Battery Backup (included).

Input: 120 volt AC 60 Hz +/- 1 Hz.
Output: 120 volt AC, 500VA, 300 watts
Surge Energy Rating: 365 joules

F. Additional Equipment

1. Wireless Receiver Switches: Switches shall receive time packets from the Primary Transmitter and relay the synchronized time to the Satellite Transmitter connected to it. The unit shall include the following:
   a. Antenna mounted on top of the switch housing, 11½-inches (292mm) long. Power Supply:
      · Input 120 VAC 50/60Hz, 0.4 amps
      · Output: 9 volt DC, 1.5 amps RS 232 data cable, 5 feet (1.5mm) long
   b. Daylight Savings Time bypass switch
   c. Dimensions: 4¼-inches (108mm) long, 5¾-inches (146mm) wide, 1¼-inches (31.75mm) deep.
   d. Weight: 12 ounces (.34kg)
   e. Operating Range: 32 degrees F to 158 degrees F (0 to 70 degrees C)
2. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:
   a. Antenna mounted on top of the housing, 46 inches (1168mm) long.
   b. Wireless Receiver Switch.
   c. Power Supply Input: 120
   d. VAC, 50/60Hz, 0.4 amps
   e. Output: 9 volt DC, 1.5 amps.
   f. 6 foot (1.83m) cord
   g. Surge Suppressor/Battery Backup
   h. Mounting Shelf.
   i. Transmission Power: 1 watt maximum
   j. 72 MHz frequency.
3. Traditional analog clocks (battery): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black.
   a. 9 inches (228.6mm) diameter analog clock: Primex Wireless Model 14280
   b. 12½-inch (317.5mm) diameter analog clock: Primex Wireless Model 14155
   c. 16 inches (406.4mm) diameter analog clock: Primex Wireless Model 14163
   d. 24 inches (610mm) diameter analog clock: Primex Wireless Model 14346
4. Additional colors, finishes, and dial faces are available from Manufacturer.
   a. Analog clocks shall be battery-operated,
   b. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function If desired.
   c. Time shall be automatically updated from the transmitter 6 times per day.
   d. Analog clocks shall remember the time during changing of batteries.
   e. 9 inches (228.6mm) and 12.5 inches (317.5mm) analog clocks shall have a tamper proof/ theft resistant clock lock mounting slots.
5. Analog clock receivers shall be as follows:
   a. Receiver sensitivity: >-110 dBm
   b. Receiver power: 24 VAC or 120 VAC (see model #)
   c. Antenna type: internal
   d. Antenna gain: -7 dBd

   If transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission

is not restored after 96 hours, the second hand will “five step” as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.

6. Wire guards: Provide one for each analog clock as follows:
   a. Analog clock wire guard Primex Wireless Model 14131, 14-inches by 14-inches (355.6 by 355.6 mm) size, for nominal 12½-inch (317.5 mm) diameter analog clocks.
   b. Analog clock wire guard Primex Wireless Model 14123, 18-inches by 18-inches (457.2 by 457.2mm) size, for 16 inches (406.4mm) diameter analog clocks.
7. Cable Connection Sealant: Radio Shack Coaxial Cable Connector Sealant 278-1645, or approved electrical grade silicone sealant.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

B. Verify that 120-volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

3.2 INSTALLATION

A. Provide All Equipment necessary for a complete and operable system.

B. Transmitter:

Locate transmitter where indicated, a minimum of 2 feet to 3 feet (.6 to 1 meter) above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. Transmitter(s) will be placed at locations indicated below:

1. Attach receiver to transmitter using cable.
2. Connect antenna to transmitter, using care not to strip threads.
3. Connect power supply to the transmitter. Set the channel number on the display to correspond to the FCC license.
4. Plug power supply into electrical outlet.

C. Analog Clocks shall perform the following operations with each clock:

1. Set clock to correct time in accordance with Manufacturer's instructions.
2. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
3. Install the analog clock on the wall in the indicated location, plumb, level and tight against the wall. If using 12½-inch (317.5mm) clock, attach using clock-lock hanging method and suitable fasteners as approved by Clock Manufacturer.
4. Wire guards: Secure to wall, using approved theft-resistant fasteners.

3.3 ADJUSTING

A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 CLEANING

A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by Clock Manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION

A. Provide Training to District's Representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 PROTECTION

A. Protect Finished Installation Until Final Acceptance of the Project.

3.7 TESTING

A. All Devices must be tested at their operational location under normal operational conditions to assure reception of signal.

END OF SECTION 275313
070317/1010006

SECTION 280500
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements and conditions which pertain to the furnishing and installation of a functional security system.

B. The Security Contractor will be engaged to perform the work detailed in a highly confidential and proprietary environment. All technical specifications, submittals and other documentation related to this project are considered confidential information and must remain secure at all times.

C. All project coordination shall be through the Owner's Consultant/Representative, Guidepost Solutions. Contact information: Contact, e-mail, phone:

Mike Niola
Email: mniola@guidepostsolutions.com
Office #: 213-598-1205

1.2 RELATED SECTIONS

A. Section 280513 Conductors and Cables for Electronic Safety and Security

B. Section 280800 Security System Commissioning

C. Section 281300 Access Control & Alarm Monitoring System (ACAMS) D. Section 282300 Video Surveillance

D. Coordinate door hardware with the Division 8 Hardware contractor

E. Coordinate all electrical power and conduit requirements with the Division 26 electrical contractor and the Owner. All security systems shall be on a dedicated security designated branch circuits.

F. General and Supplementary Conditions: Drawings and general provisions of Contract apply to all Division 28 sections

1.3 REFERENCES

A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.

B. Codes: Perform work in accordance with all applicable requirements of the latest edition of all governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

1. ADA – Title 3 of the Americans with Disabilities Act
2. Uniform Building Code (UBC).
3. Uniform Fire Code (UFC).
4. National Electric Code (NEC), NFPA 70.
5. Uniform Mechanical Code (UMC).
6. National, State, Local and any other binding building and fire codes.
7. FCC Regulations:
8. Part 15 – Radio Frequency Devices & Radiation Limits
9. Underwriter's Laboratories (UL): Applicable listing and ratings.
10. UL 294: Access Control System Units
11. UL 1076: Proprietary Burglar Alarm Units and Systems
12. EIA testing standards

C. Electronic devices radiating "RF" energy shall comply with Federal Communication Commission regulations, particularly Part Fifteen, and shall meet minimum Class "B" requirements.

1.4 DEFINITIONS

A. The Definitions of Division 1 shall apply to all Division 28 sections.

B. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:

1. "Furnish": To purchase, procure, acquire, and deliver complete with related accessories.
2. "Install": To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the Owner, all parts, items, or equipment supplied by contractor. Installation shall be complete and ready for regular operation.
3. "Provide": To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation.
4. "Connect": To install all required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.
5. "As directed": As directed or instructed by the Owner, or their authorized representative.
6. "Cabling": A combination of all cables, wire, cords, and connecting hardware [e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling].
7. “ACAMS”: Access Control & Alarm Monitoring System
8. “ACP”: Security Equipment Panels
9. “VMS”: Video Management System

1.5 OUTLINE OF WORK

A. Overview

1. The work includes, but is not limited to providing all materials, transportation, equipment, and performing all operations required to complete the security systems as indicated on the drawings and specified herein. Provide equipment, whether specified or not for a complete and working system.
2. Examine the drawings and specifications of other trades, noting all conditions affecting this section of work. Care and coordinate for same in executing the contract. The entire responsibility for completion and supplying an operating system shall be delegated to the Security Contractor.
3. Work called for on the drawings and not mentioned in the specifications or vice-versa, shall be performed as though fully set forth in both. In the case of differences between the drawings and specifications, the decision of the Owner shall govern. Work not particularly detailed, marked, or specified, shall be the same as similar parts that are detailed, marked or specified.
4. The Security Contractor has overall responsibility to oversee, coordinate, and cooperate with other contractors in the conduct of the work outlined. Security Contractor will participate in weekly status calls and/or be onsite as needed for coordination meetings.
5. The Security Contractor will be responsible for supplying all copper and fiber network patch cables and all security devices as detailed in this specification including the cameras, card readers, door contacts, security and Video panels, power supplies, final device connections (including lock hardware), and all devices indicated on security drawings.
6. The Security Contractor will be responsible for verifying all installed copper cabling connectivity and verifying suitable cable has been installed to provide full system functionality.
7. The Security Contractor will provide all final terminations to include security components and door locking hardware.
8. The objective of the project is to utilize the existing ONSSI video management system. The new system/components will be networked with the owners existing Video Management Platform.
9. The access control platform shall be an Enterprise server. Each new field panel/ controller(s) shall be its own LAN chain.
10. Additional objectives will include installing additional security components as outlined in the Security Equipment (SE) Drawings.
11. If a fire alarm cross connection is required the Security Contractor shall be responsible for all coordination, equipment, installation and testing between the building owner’s life safety system service provider and the owner’s new Access Control system. The Security Contractor is responsible to provide all required cabling between all life safety systems and Access Control devices.
12. The Security Contractor shall insure that all new access control field panels are installed as indicated on the SE Drawings. All electrical connections will be completed internal to the equipment cabinet.

13. New camera power supplies shall be installed as shown on the SE drawings.
14. The Security Contractor shall provide new contact/tamper switches in all field panels.
15. The Owner's system administrator will provide all access and video system programming with the exception of initial LAN programming required to bring new security components on-line. The Security Contractor will perform all LAN programming and provide the system administrator with the information used to program each device. This includes IP addresses; hardwire addresses and passwords for cameras and IP addresses for access control panels. Programming for Intercom exchanges and master intercoms shall be the responsibility of the security contractor.
16. The security contractor will provide and install resistors at the following devices for 4- state supervision - supports secure, alarm, short circuit and open circuit states:
    a. Position switches
    b. Request to exit devices
    c. Motion detectors
    d. Exit alarms
    e. Door management alarms
    f. Glass break devices

B. Work Not in Security Contractor's Scope
    1. The General Contractor, unless otherwise noted on the SE design drawings, will be responsible for supplying all copper cabling (to include network, and security device specific), all conduits, all cable trays / baskets, and all (electrified / non-electrified) door hardware including micro Request to Exit Switches for the project.
    2. Electrical outlets shown on the "SE" drawings are for information only and appear on the Electrical Drawings for circuits and loads. Electrical contractor will provide all 110VAC power requirements.
    3. The owner will supply all computing hardware including workstations, servers, video storage, and network switch gear.
    4. Power supplies where electrified hardware requires local power.

C. Required submittal with bid package
    1. The Security Contractor shall submit separate pricing packages as outlined on the "Bid Compliance Form". Quantify total pricing into the categories of system materials, cable, installation labor, project management, engineering and drafting. Use the provided pricing matrix worksheet forms and supply a complete list of materials including quantity, manufacturer, model number and description. Pricing matrix must be returned in Microsoft Excel format.
    2. Include the material list with UNIT PRICING FOR EACH MAJOR PIECE OF EQUIPMENT. Unit pricing must include material per unit and the labor charge per unit inclusive of installation, engineering and project management.
    3. Provide the resume of the Project Manager with three (3) references to similar completed projects.
    4. Provide Certificates of Certification for each associate performing installation, programming and commission work in the bid response.
    5. List subcontractors by:
        a. Name
        b. Primary Role
        c. Physical address and distance from job site
        d. Three (3) references to similar completed projects
    6. The Security Contractor must submit a Proposed Project Schedule utilizing current project management software (MS Project preferred) detailing their project approach and milestones to complete all specified systems within 10 days of project award. This schedule should detail not only the tasks to be completed, but the resources the Security Contractor will commit to achieve the Owner's scheduling requirement. The schedule should identify each device outlined on the SE drawings; indicate incremental measurements relating to the status of each device. The incremental measurements will be:
        a. "Pre-Wiring" due date and % complete
        b. "Hardware Installed Date" due date and complete
        c. "Operational Date" due date and % complete

1.6 SUBMITTALS

A. General: Submit required submittal(s) in accordance with General Conditions of the Contract, and Division 1 Submittal Procedures

B. Cover Letter: Include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. List in full the items and data submitted, signed (and stamped, if applicable) by the person who prepared the submittal. Failure to comply with this requirement shall constitute grounds for rejection of submittal.

C. Submittal Description: Product Data

1. General: Product data submittals must be submitted within 4 days of Notice to
2. Proceed.
3. Quantity: 2 sets (one to the GC and one to Guidepost Solutions)
4. Format: PDF or other computer media.
    a. Clearly label the cover of each submittal package with the following information:
        1) Client Name (e.g., “Rancho Santiago College District”).
        2) Project Number and Contract Number.
        3) Project Name and Address (e.g., “Project Name”).
        4) Contractor’s Submittal Number.
        5) Submittal Title (e.g., “Product Data Submittal For ACAMS System”).
        6) Specification Section Number (e.g., “Section 28 23 00”)
        7) Date of Submittal. Format: <month> <day>, <year> (e.g., “January 1, 2008”).
        8) Contractor Name.
    b. Include a Table of Contents at the beginning of the submittal that lists materials by article and paragraph number found in the section and in the order outlined in the specification (e.g., “2.03-b Card Reader”).
    c. Delivery dates for all equipment.

D. Content:

1. Product Information:
    a. Include product data consisting of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product’s characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements.
    b. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded.
    c. Include delivery dates for equipment.

E. Submittal Description: Shop Drawings

1. General: Engineered shop drawings must be submitted within 10 days of Notice to
2. Proceed.
3. The Owner / Owner’s Representative will provide electronic files via e-mail or via CD- ROM containing the contract documents drawing files for use in preparing shop drawings.
4. Quantity & Media: Furnish quantity and on media specified in Division 1.
5. Format: Use AutoCAD Version 6.0 or later.
    a. Use the same sheet size and project title block as the Drawings. c. Use identical symbols as those in the Design Drawings.
    b. Screen background information
    c. System components (devices, cable routes, etc.) and text shall be plotted at a sufficient line weight to stand out against background information.
    d. Each sheet in the shop drawings set shall be labeled with the Specification
    e. Section Number (e.g., “282300”).
6. Content:
    a. Floor Plans:
        1) Floor and site plans showing the locations of all devices and door furniture associated with each door locations (ex: contacts, REX, locks, card readers) and cable routing paths with cable type and quantity called out. Prepare cable schedule if required to simplify sheet plan notation

2) Provide termination information for each device on the plans or in a schedule that identifies the physical connections to the equipment panels. Include the panel address, and the termination point ID that is consistent and reflective of the programming fields.

b. Point-to-Point Diagrams: Include all wiring, points of connection and interconnecting devices.
   1) Include all miscellaneous control relays.
   2) Include all devices connected to the system.
   3) Identify all conductors on the point-to-point diagrams with the same tag as the installed conductor.

c. Block Diagram/Riser Diagram: Show the system components and all conduit and wire types and sizes between them including all cabling inter-ties between termination hardware.

d. Installation Details: Include installation details for all devices.

F. Submittal Description: Labeling Sample
   1. Quantity & Media: Furnish quantity indicated in Division 1.
   2. Submit two sets of physical product samples for review and comment by Owner prior to the installation of equipment:
   3. Content:
      a. Provide panel label
      b. Provide cable label on a cut length of cable.

G. Submittal Description: Record Drawings
   1. Quantity & Media:
      a. Submit a complete set of red-line prints for use in compiling record drawings for review by the Owner upon completion of the project.
      b. Fully represent actual installed conditions and incorporate all revisions made during the course of construction.
      c. Include drawings submitted as part of the Shop Drawing package, plus any additional information required to accurately document installed conditions.
      d. Device addresses & IP address information.

H. Floor plans shall show:
   a. Locations and identifiers of all devices.
   b. Size, quantity, location, and routes of all pathways (such as cable trays, conduits, J-hangers, and other cable support devices).
   c. Floor plans showing exact placement of all equipment ACP's, card readers, alarms, cabinets/frames, rack bays, and other equipment.
   d. Installation details.

1.7 SUBSTITUTIONS

A. Substitution of products, materials, and equipment after RFP due dates may be accepted only when there is a significant advantage to the Owner created by an overall upgrading of a component by a manufacturer or an operational advantage created by a modification to the equipment proposed as a substitution. In the event any substitution is requested, the Security Contractor shall make the Project Consultant aware of the proposed new products, materials, and equipment and shall provide the following information:
   1. Complete technical information on the products, materials, and equipment proposed.
   2. A copy of the original equipment data sheet along with a brief summary that identifies the advantages of the new equipment's application within the system(s).
   3. Project cost impact showing the amount to be deducted or any additional cost of the equipment to be replaced. Pricing shall include the direct cost of the new equipment proposed, the cost of engineering to modify the Contract Documents and the site specific Drawings and Statement of Work for each Project, and the cost of additional labor (if any) to install the new equipment.
   4. The Security Contractor shall include in his quote all incidental and related cost by other contractors or subcontractors to make the proposed changes.

B. Under no circumstances will a change in the originally specified products, materials, or equipment be made unless approved in writing by the Owner.

1.8 QUALITY ASSURANCE

A. Contractor Qualifications
   1. Primary business locations from which project management, installation technicians, and service personnel are dispatched, to ensure response time for technical assistance within 4 hours.
   2. At least 5 years of experience, and a minimum of five satisfactory completed projects similar in scope and cost.
   3. Provide a resume of satisfactory evidence of project manager, foreman, and lead technician's qualifications and certifications by the manufacturer for the work.
   4. A current dealer training certification indicating that contractor has attended training and successfully completed the training course.
   5. A current, active, and valid State Contractors License.
   6. Authorized reseller/dealer, warranty provider, and a factory certified installer of the ACAMS security system.

B. Permits and Inspections
   1. Obtain and pay for permits and inspections required for the work.
   2. Furnish materials and workmanship for this work in conformance with applicable legal and code requirements.

C. Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of any legal authority having jurisdiction.

D. Obtain review from compliance officials responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with all requirements of reference codes indicated herein.

E. Materials
   1. Provide new and unused materials, equipment, and parts of current manufacturer and without defects for the units specified herein.
   2. Furnish only specified products and equipment, or products and equipment that have been approved in writing.

F. Regulatory Requirements
   1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Nothing in these specifications is to be construed to permit work not conforming to the most stringent of the applicable codes.
   2. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid. Consider such codes or standards a part of this Specification as though fully repeated herein.
   3. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this series of Sections, nothing in said codes shall be construed or inferred authority for reducing the quality, requirements or extent of the Drawings and Specifications. The Contract Documents address the minimum requirements for construction.

1.9 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Overview: Provide a project manager/engineer for the duration of the project to coordinate the security system work with all other trades. Coordination services, procedures and documentation responsibility shall include, but shall not be limited to the items listed in this section.
   1. Obtain copies of all shop drawings and product data for equipment provided by others that require security connections or interface with the security system work.
   2. Prepare and maintain a shop drawing review log indicating the following information:
      a. Shop drawing number and brief description of the system/material.

b. Date of your review.
c. Indication if follow-up coordination required.

B. Request for Information (RFI)
1. Thoroughly review the contract documents prior to the preparation and submission of an RFI. If an RFI is submitted, attach 8 1/2" x 11" copies of all relevant documents to clarify the issue.
2. Prepare and maintain an RFI log using a Microsoft Excel spreadsheet indicating the following information:
a. RFI number and brief summary of the issue.
b. Date of issuance and receipt of response.

C. Scheduling of Work
1. Prepare work schedules for each floor / building indicating the following information:
a. Cable installation dates.
b. ACP build-out dates.
c. Device installation dates.
d. Programming dates.
e. Testing dates.

D. Role of the Security Consultant
1. During the construction phase of the project, the Consultant will work with the Contractor to provide interpretation and clarification of project contract documents, reply to (and 'process') relevant Requests for Information (RFIs), and act as an interface between the Contractor and the Owner.
2. The Owner has retained the Consultant's services to observe the Work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system.
3. In summary, the Consultant will perform the following specific services during the construction phase:
a. Review product submittals and shop drawings for general compliance with the contract drawings and specifications.
b. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
c. Interpret field problems for Owner, and translate into understandable language.
d. Review the testing procedures to confirm compliance with industry-accepted practices.
e. Oversee security works through interface with the security contractor and OAC meetings.
f. Final commission testing and acceptance of all security related equipment.

1.10 DELIVERY, STORAGE AND HANDLING

A. Delivery
1. Do not deliver products to the site until protected storage space is available.
2. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at jobsite.
3. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels (name of the manufacturer, product name, type, grade, UL classification, etc.) intact.
4. Replace materials damaged during shipping at no cost to the Owner.

B. Storage
1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
2. Comply with manufacturer's requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Material Safety Data Sheets (MSDS) as applicable.
3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
4. Storage outdoors covered by rainproof material is not acceptable.
5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
   1. Handle in accordance with manufacturer's written instructions.
   2. Damaged equipment shall not be installed.
   3. Replace damaged equipment at no cost to the Owner.
   4. Handle with care to prevent internal component damage, breakage, denting, and scoring

1.11 WARRANTY

A. Provide a one year parts and service warranty at no additional cost to the Owner from date of acceptance of the system by the owner.

B. Warranty begins when system commissioning is completed, punch-list items resolved, and Owner provides in writing acceptance of system.

C. The warranty package shall include but not necessarily be limited to the following:
   1. Emergency maintenance service on a regular working hour basis.
   2. Service by factory trained and employed service representatives of system manufacturer.

D. Maintain regular service facilities and provide a qualified technician familiar with this work at the site within four (4) hours of receipt of a notice of malfunction including weekends and holidays. Provide material, devices equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by the Owner, complete and operational within twenty-four (24) hours after notification of a malfunction, at no additional cost.

E. Conduct warranty repairs and service at the job site unless in violation of manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to the Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts and personnel to and from the job site at no additional cost.

1.12 PART 2 - PRODUCTS

2.0 NOT USED – REFER TO ADDITIONAL SECURITY SECTIONS FOR PRODUCT DETAIL

PART 3 - EXECUTION

3.0 EXAMINATION

A. Verify existing conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. Verify that all penetrating elements and supporting devices have been properly installed, and that all temporary lines, and markings, have been removed.

3.1 PREPARATION

A. Staffing
   1. Provide a qualified foreman in charge of the work at all times and be present at the job site during the installation of the work.
   2. Provide a supervised work force capable of performing the installation within the restraints of the construction schedule.
   3. Site work hours for this project are 8:00 a.m. to 5:00 p.m. Monday through Friday.
   4. Work to be performed outside of these hours must be approved in advance by the Owner.

B. Project Management
   1. Prepare an overall construction schedule based on the results of the planning meetings with the Owner.
   2. Prepare updated schedules whenever there are modifications. Coordinate and attend weekly status meetings to review the overall progress and issues to be resolved throughout the course of construction. The Contractor is responsible for preparing and distributing meeting agenda prior to and meeting notes after all meetings in a format acceptable to the Owner.

C. Safety Program
   1. The Security Contractor shall furnish to the Owner, the Owner's Representative and the project General Contractor three (3) copies of the Security Contractor's published safety program
   2. All associates working at the site must comply with all safety requirements including but not limited to site safety training and certification programs conducted by the General Contractor.

3.2 INSTALLATION

A. Perform this work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.

B. The work shall be performed by skilled installers under the direction of experienced technician, all of whom shall be properly trained and qualified for this work.

C. A complete, operating system shall be provided. Include all devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.

D. Provide wire, system cabinets, system devices, etc., shall be in accordance with applicable codes for systems as specified. Label all wiring and equipment.

E. The control equipment and wiring shall be installed in a neat and workmanlike manner by trained mechanics or electricians.

F. Auxiliary and incidental equipment necessary for the operation and protection of the systems specified in this section shall be furnished and installed as if specified in full herein.

G. Install the Security System with the full support of the manufacturer of the system components.

H. Coordination
   1. Maintain a competent supervisor and supporting technical personnel, acceptable to the Owner during the entire installation. Change of supervisor during the project shall not be acceptable without prior written approval from the Owner.
   2. Communications between the Security Contractor and the Owner, the Owner's Consultant and the project General Contractor will be frequent and necessary. Items discussed or agreed that involve interpretations to the plans or specification, methods of installation, or clarification must be confirmed in writing. Verbal agreements not confirmed in writing on documents acceptable to the Owner shall not be binding.
   3. The Security Contractor shall maintain at the site a complete set of all specifications, drawings and submittals in accordance with the Contract Documents.

I. Boxes, Panels, and Enclosures
   1. Install all boxes, panels, and enclosures square and plumb. Set all "flush mounted" units so that the face of the cover, bezel or escutcheon shall be in the same place as the surrounding finished surface. Mount boxes, panels and trim so that there are no gaps, cracks or obvious lines between the trim and the adjacent finished surface and ready them to receive final finish, as applicable.
   2. Install insulating terminations in signal circuit boxes, panels, wire ways or enclosures of this section.
   3. Provide key locks on all enclosures that are accessible and below the ceiling.
   4. Provide tamper switches on all enclosures that are accessible and below the ceiling.

3.3 REPAIR / RESTORATION

A. Replace or repair work completed by others that you deface or destroy. Pay the full cost of this repair/replacement.

B. Punch List:
   1. Inspect installed work in conjunction with the General Contractor or Owner and develop a punch list for items needing correction.
   2. Provide punch list to Owner or Owner representative for review prior to performing punch walk with the Owner's Representative.

C. Re-Installation:
   1. Make changes to adjust the system to optimum operation for final use. Make changes to the system such that any defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
   2. Repair defects prior to system acceptance.

D. Rejected Work:
   1. Promptly correct all Work rejected by the Owner, as defective or failing to conform to the Contract Documents and the site specific Drawings. This shall apply whether observed before or after acceptance and whether or not installed or completed.
   2. The Security Contractor shall bear all costs of correcting such rejected work. Cost of work corrected after acceptance shall be fully covered under Security Contractor's warranty.

3.4 TRAINING

A. The Security Contractor will assist by supporting the Security Consultant's training program by supplying a minimum of 4 hours training on the security systems installation. The training shall be performed at times agreed upon by SAC.

B. The Security Contractor shall furnish 3 copies of all training materials at the time of training.

C. One copy shall be submitted to the project consultant a minimum of one week prior to the training for review and comments. All Owner/project consultant generated training comments shall be integrated into the final training materials.

D. Training materials shall include hard and soft copies of the operator's manuals, maintenance manuals, course notes and a system description narrative.

3.5 FINAL DOCUMENTATION

1. Quantity: Furnish two (2) O & M Manuals and record drawing sets.
2. Format:
   a. Furnish each O & M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
   b. Clearly label the cover of each O & M Manual with the following information:
      1) Client Name.
      2) Project Name and Contract Numbers.
      3) Project Name and Address.
      4) Manual Name (e.g., "Operation And Maintenance Manual for ACAMS System).
      5) Date of Submittal. Format: <month> <day>, <year> (e.g., "January1,2008").
      6) Contractor Name.
   c. Include a Table of Contents at the beginning that lists the contents.
   d. Include tabbed separators for improved navigation through the manual.
3. Content:
   a. Functional Design Manual: Includes a detailed explanation of the operation of the system.
   b. Hardware Manual which includes:
      1) Pictorial parts list and part numbers.
      2) Pictorial and schematic electrical drawings of wiring systems, including devices, control panels, instrumentation and annunciators.
      3) Telephone numbers for the authorized parts and service distributors.
      4) Include all service bulletins.
   c. Operator's Manual which fully explains all procedures and instructions for the operation of the system and includes:
      1) System start-up and shut down procedures.
      2) Use of system.
      3) Equipment recovery and restart procedures.
      4) Reader command functions
   d. Maintenance Manual which includes:
      1) Instructions for routine maintenance listed for each component and a multi-page summary of all components' routine maintenance requirements.
      2) Detailed instructions for repair of the security system.

3) A summary of the TCP/IP address used and which system component they are associated with. Include the gateway address, subnet mask, DNS server, and host name information.
4) Manufacturer's warranty certificates.

e. e.Record Drawings Manual: 11"x17" prints of Record Drawings, as described above. Provide one Record Drawing set per panel location.

B. Re-submittals: Include a cover letter listing the action taken and revisions made to each product submittal in response to Submittal Review Comments. Re-submittal packages will not be reviewed unless accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.

END OF SECTION

SECTION 280513
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. General: Electrical Contractor to provide all cable/wire rough-in, preliminary labeling, conduits, cable trays, pathways and mounting of copper and fiber cabling.

B. Security Contractor is responsible to furnish all copper and fiber patch/cross-connect cables. Security Contractor to test and verify suitability and connectivity of all cable runs installed by others, and note any problems to the Security Consultant.

C. Security Contractor is responsible to furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working security system installation, as described in these specifications.

D. Security Contractor is responsible for final labeling of access control, video, and network cables at equipment cabinet. Labels to be used are manufactured by Panduit model PAN-TY; white in color.

E. Section Includes:

1. Wiring and cable
2. Surface Mounted Raceway
3. Anchors and Fasteners

F. Coordinate all electrical power and conduit requirements with the Owner. All security systems shall be on a dedicated security designated branch circuit, unless otherwise approved by the Owner.

1.2 RELATED SECTIONS:

A. Consult other Divisions; determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.

B. Section 280500 Common Work Results for Electronic Safety and Security

C. Section 280800 Security System Commissioning

D. Section 281300 Access Control

E. Coordinate door hardware with the Division 8 Hardware contractor.

F. General and Supplementary Conditions: Drawings and general provisions of Contract and

1.3 SUBMITTALS

A. Submit in accordance with the requirements of Section 280500: Common Work Results for Electronic Safety and Security, the following items:

1. Product Datasheets
2. Cable Riser Diagram in shop drawings
3. Pre-Test documents

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. General

1. Electrical Contractor to provide all necessary conduit, wire basket, cable supports and J-Hangers dedicated for security cable. Do not share conduits with fire alarm systems.
2. Electrical Contractor provide required wire and cable sized to allow for voltage drop on long runs and effectively shielded as required to allow the routing of 12 & 24V power and video signal cable in the same conduit without interference or signal noise.

3. Cable installed outdoors or in underground conduit must contain a PVC or Polyethylene jacket, flooded to prevent water intrusion.
4. Cables installed outdoors or in underground conduit that transition into the building and run in plenum space to contain a plenum rated (type CMP) jacket and contain water block material to prevent water intrusion.
5. Cables installed indoors to contain a plenum rated jacket (type CMP)
6. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit. Do not use spring steel clips and clamps. Do not use power –actuated anchors.
7. Permission for any drilling or cutting of the building structural member must be obtained from the Owner.
8. Fabricate supports from structural steel angle or structural steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
9. Install surface-mounted cabinets and panel boards with minimum of 4 anchors.
10. Materials and finishes shall be corrosion resistant.

B. Manufacturers:
   1. Belden

C. Access Control System
   1. Provide plenum rated cable. Composite cable may be used if the below individual specifications are met. Cable requirements and locations are shown per door details on SE drawings.
      a. Belden 658AFS for Card Readers (CR) – Plenum rated composite security access control cable
      b. Belden 6502FE for Contact Points (C) – Plenum rated 4 conductor shielded cable
      c. Belden 6502FE for Emergency Buttons (EB) – Plenum rated 4 conductor shielded cable
      d. Belden 1874A for CAT6 network cable – Plenum rated network cable

2.2 SURFACE MOUNTED RACEWAY

A. General
   1. Conduit, raceways, and device j-boxes are to be provided by the electrical contractor.
   2. Cable shall be concealed in conduit from all devices to the cable tray.
   3. Cable trays shall comply with current issued standards.

2.3 ANCHORS AND FASTENERS

A. General
   1. Steel Structural Elements: Beam clamps and welded fasteners.
   2. Concrete Surfaces: Self-drilling anchors and expansion anchors.
   3. Hollow Masonry, Plaster, and Gypsum Board Partitions: Toggle bolts and hollow wall fasteners.
   4. Solid Masonry Walls: Expansion anchors
   5. Sheet Metal: Sheet metal screws
   6. Wood: Wood screws

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify all wire and cable clearly with permanent labels wrapped about the full circumference within one (1) inch of each connection. Handwritten labeling is not acceptable. Indicate the number designated on the associated field or shop drawings or run sheet, as applies. Assign wire or cable designations consistently throughout a given system; i.e., each wire or cable shall carry the same labeled designation over its entire run, regardless of intermediate terminations. Additionally, provide labels where wire and cable first enter and exit from conduit, junction or distribution boxes; labels shall be located within six (6) inches of the point of exit. Labels shall be by Panduit or equal.

B. All vertical wire and cable runs shall be installed in conduit.

C. All wire and cable shall be continuous and splice free for the entire length of run between designated connections or terminations.

D. Make all connections to screw type barrier strips on panels and with insulated crimp type spade lugs when appropriate or terminal blocks rated for the wire size used. Size all lugs properly to assure high electrical integrity, i.e., low resistance connections.

E. Lace, tie or harness wire or cable as required herein using Velcro straps, and in accordance with accepted professional practice. Dress, lace or harness all wire and cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point.

F. Wiring for shielding certain conductors from others or routing in separate raceways, shall be as recommended by the manufacturer's current requirements.

G. All wiring shall be installed in a continuous steel conduit system when not located above accessible ceiling and shall be of the size recommended by the equipment supplier.

H. Provide all necessary tie wires.

I. Label all cables at both ends of a run and within all pull and junction boxes using machine generated wrap-around labels.

J. Follow manufacturers recommended guidelines for installation. K. Label Power Circuits at panel locations

K. Provide 3 foot minimum service loop for all wiring at head-end location. Service loops shall be concealed.

L. Provide 10 foot minimum service loop for all camera locations in the field.

M. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from Owner's designated Construction Project representative.

N. When penetrating a fire wall for passage of cables and/or conduit, always provide a fire-stop system that complies with code and the local authority having jurisdiction.

END OF SECTION

SECTION 280800
SECURITY SYSTEM COMMISSIONING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes

1. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working Access control and Video Surveillance System installation as described in these specifications and shown in detail on the drawings.

B. Base Bid Work

1. Full testing of completed security system which includes:
   a. Complete pretest of the security system
   b. Final walk test with the Owner
   c. Test Results Record Documentation
2. Coordinate network connectivity and data cable requirements with local IT for connection to existing network switch as shown on plans. Provide and install cabling as needed.
3. All security systems shall be on a dedicated security designated branch circuit. Contractor to provide power as needed. Coordinate with owner prior to installation.

1.2 RELATED SECTIONS:

A. Consult all other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to test a complete and operable system.

B. Section 280500 Common Work Results for Electronic Safety and Security

C. Section 280513 Security System Cabling Standards

D. Section 281300 Access Control & Alarm Monitoring (ACAMS)

E. Coordinate door hardware with the Division 8 Hardware contractor.

F. Coordinate all electrical power and conduit requirements with the Owner. All security systems shall be on a dedicated security designated branch circuit, unless otherwise approved by the Owner.

G. General and Supplementary Conditions: Drawings and general provisions of Contract and Division 1 of the Specifications, apply to 28xxxx series Sections.

1.3 SUMMARY OF SYSTEM COMMISSIONING ACTIVITIES

A. Overview

1. The purpose of system commissioning is to ensure the security system operates properly when it is needed most. Security systems are very complex from both equipment and programming standpoint, and thorough testing is necessary to ensure correct operation.
2. Perform testing activities when the system is “quiet” and the building is generally unoccupied. This will minimize the amount of irrelevant activity in the system activity reports that will be used as a record of the pre and final test results

B. Pre-Test

1. Perform a 100% pre-test of all system aspects to verify correct operation prior to scheduling the final test. The pre-test will help to make the final test run smoothly when demonstrating the system’s operation to the Owner.
2. Document the results of the pre-test using the approved test forms and submit a copy to the Owner along with the system activity reports.

C. Final Test

1. Perform a final test of the system in the presence of the Owner to demonstrate correct operation of the security system.
2. Recommendation for acceptance by the Owner's or the Owner's Representative will be generated if all of the following conditions have been satisfied:
   a. All items conform to the plans and specifications.
   b. All previous deficiencies or errors have been corrected.
   c. All deficiencies noted during the final test are corrected.
   d. All systems are complete and working according to the intent of the Contract Documents.
3. If deficiencies still exist, recommendations for acceptance will be withheld or qualified until all items have been corrected and re-inspection is completed as outlined above.
4. Final acceptance will not occur, even if all systems are acceptable, until all documentation to include as-built drawings and operation/service manuals have been received, reviewed, and approved by the Owner or the Owner's Representative.
5. The warranty/guarantee period shall commence once final testing of the system has been completed, all manuals and documentation have been reviewed and approved, and the Owner has accepted the system in writing.

1.4 SUBMITTALS

A. Submit in accordance with the requirements of Section 280500: Common Work Results for Electronic Safety and Security, the following items:
   1. Sample Test forms
      a. Provide sample test forms that will be used in the pre and final system tests. Furnish the required quantity of each submittal indicated in Division 1.
   2. Operation and Maintenance Manuals: Submit the following for review and comment at the completion of the project and before final testing occurs:
      a. Functional Design Manual
      b. Hardware Manual
      c. Software Manual
      d. Operator’s Manual which full explains all procedures and instructions for the operation of the system and includes
      e. Maintenance Manual
      f. Test Results Manual, which includes the document results of all tests, required under this Specification, organized by System, Floor, and Door.
      g. Record Drawings Manual
   3. Record Drawings:
      a. Submit for review and comment at the completion of the project:
      b. Final acceptance will not be made until the record drawings approved by the Owner.

1.5 QUALITY ASSURANCE

A. General
   1. All testing work shall be completed in a neat, high quality manner acceptable to the Owner.

B. Project Management and Coordination Services
   1. Provide a project manager to coordinate the security system commissioning work with all other trades.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.0 SCHEDULING

A. Prepare a construction schedule based on the schedule developed in Section 280000 for the testing activities. Prepare updated schedules whenever there are modifications.

1. Approved Substitutions: Due to the presence of an existing system that will share database information with this project, no substitutions will be considered.

3.1 TESTING REQUIREMENTS

A. Site Tests
   1. Perform a 100% pretest of the system prior to final testing by the Owner. The pretest must occur prior to substantial completion of the system, with the final inspection no later than seven (7) days prior to final acceptance in order to meet the Owner's timetable for systems familiarization.
   2. The Security Contractor shall include the cost of these tests and adjustments in his bid proposal, and shall furnish all equipment necessary and perform all work required to determine or modify the performance of the System in accordance with the Contract Documents.
   3. At the conclusion of the work on a floor, test the system on that floor to verify proper operation and reporting of devices.
   4. Work with the door hardware supplier to resolve any electric hardware failures and door alignment/closure problems.
   5. At the completion of all work, test the entire system to verify proper operation. These tests shall include:
      a. Card Reader Door Test: Test doors to ensure alarm contact provide alarm activation and relock when closed, rex shunts door and command card reader bypasses alarm inputs for area when applicable.
      b. Card Reader/ADA Test: Test doors according to card reader test above. In addition, test ADA push plate interlocking function to ensure door does not operate when locked. Test that interior ADA actuator always functions.
      c. Door Contact Test: Test doors to ensure local alarm, activation and deactivation of alarm output.
      d. Emergency Button Test: Test help button devices to ensure activation and alarm reporting.
      e. Security Equipment Room Test: Inspect all system panels, power supplies, and other related security equipment located in these areas. Test AC, Battery, and communications loss.
   6. Recommendation for acceptance will be generated if all of the following conditions have been satisfied:
      a. All items conform to the Contract Documents and the site specific drawings and statement of work.
      b. All previous deficiencies noted during the final inspection are corrected.
      c. All systems are complete and working in accordance with operational criteria.
      d. All documentation and submittals required by the Contract documents and the site specific drawings have been received and approved by the owner.

B. Test Preparation
   1. Provide device identification numbers that differ from or were not included on the original contract drawing set.
   2. Furnish a complete systems point list.
   3. Include both new locations and existing locations that have new readers installed in the testing and commissioning process.
   4. During testing, provide a minimum of one technician familiar with the installation to assist with the test.
   5. Furnish radios for use by the Owner during testing.

3.2 TEST PROCEDURES

A. CARD READER DOOR
   1. Verify that the reader LED is in the RED state with the door closed.
   2. Check to see if door is locked.
   3. Present an invalid card. Reader should beep and not unlock door. An invalid card alarm will be generated in the access control system
      a. Biometric reader will turn red and not unlock door. No alarms will occur in system
   4. Present a valid card / finger. Reader LED should flash green and red during the unlock time. Unlock time should be set to 5 seconds.

a. Biometric reader will turn amber. Presenting a valid finger the LED turns green.
5. Open door and hold open until a held open alarm is generated.
6. Test for forced open. On a double door always check both leafs for forced.
7. Egress out the door and make sure you don't get a forced. On double doors exit out both leafs separately to ensure that both doors have a REX signal.
8. Verify the door has a door closer.
9. Open the door let it close on its own. Make sure that the door properly locks. If there are adjustments to be made make a note.
10. Note if there are any door stops installed. Note if there are any and recommend that they be removed.
11. Verify that card reader is labeled.
12. Verify that camera trigger is set up in the access control system.

B. DOOR CONTACTS / CABINET TAMPER SWITCHES

1. Open door. Alarm is generated by access control system.
2. Close door. Alarm remains until acknowledged.
3. Acknowledge the alarm in the access control system.

C. ACCESS CONTROL PANEL TESTS

1. Verify installation is clean, neat, and per design
2. Verify device cables and panels are labeled.
3. Verify that panels are grounded to Earth Ground.
4. Identify Power Source type:
   a. Normal
   b. Emergency
   c. UPS
5. Identify Power Circuit Information:
   a. Power Panel #
   b. Breaker
   c. Location
6. Verify Batteries are connected if wall mounted. If not wall mounted ensure panel is connected to UPS.
   a. Quantity
   b. VDC
   c. AH
7. Validate battery fail alarm.
8. Configuration Communication Functional?
9. Verify that primary communications are functional.
10. Validate panel tamper alarms work upon opening and closing of Equipment racks or wall mounted
11. Verify key locks are installed.
12. Verify 110VAC is hardwired (wall mount applications only)
13. Verify network drop is secured inside locked enclosure.
14. Verify fire relay is installed and test.
15. Verify enable learn mode.
16. Validate the following:
    a. Supports Card Usage Remaining
    b. Support Disabling Door Alarms
    c. Support Extended Triggers
    d. Supports User Initiated Door Times
    e. Anti-Pass Back Set

D. SYSTEM TEST

1. Log on Test
2. Log Off Test
3. On/Off Line Test Via Monitor
4. On/Off Line Test Via File Server
5. Comm Fail/Comm Return Test
6. Primary Communications Test
7. General System Control Test

8. (Dates, Passwords, Schedules, Etc)
9. Alarm Test (Including Silence and Acknowledge)
10. Display Screen Graphics on Alarm Test
11. Input Response to Alarm Test
12. Remote Panel Supervision Alarms Test
13. Supervisory Alarms with/without Auto-Offline
14. Operator Access Level Test
15. Command File Test
16. Command File Scheduling Test
17. Linkage Test
18. Class and Card Assignments Test
19. Backup Database Test
20. Backup History Test
21. Generate Database Reports Test
22. Generate History Reports Test

3.3 DOCUMENTATION

A. Provide an 11x17 drawing containing a detailed wiring diagram (layout of equipment/elevation, complete parts list, and a complete wiring diagram for each ACU & I/O Board) for each ACP. Fold the diagram and place it inside a clear plastic pocket affixed to the inside door of the ACP.

B. Provide a service log on the inside door of each ACP. Service log shall include columns for the following information: date of service, description of work performed, service technician(s), and service company. Place the service log inside a separate clear plastic pocket affixed to the inside door of the ACP.

3.4 DEMONSTRATION

A. On completion of the acceptance test, provide the Owner instruction in the operation and testing of the system, at a time convenient to them as defined in Section 28 05 00.

END OF SECTION

SECTION 281300
ACCESS CONTROL

PART 1 -GENERAL

1.1 SECTION INCLUDES

A. Head-end Hardware and Software

B. Software Only (owner-provided head-end CPU hardware)

C. Field Panels

D. Cards & Readers

E. Electric Locks

F. Request-to-Exit Devices

G. Wiring

1.2 SUMMARY

A. Labor and Materials: Unless otherwise noted in the Drawings and Specifications, the Contractor shall provide and pay for all labor, materials, equipment, tools, utilities, construction equipment and machinery, transportation and other facilities and services necessary for the proper execution, operation and completion of the Work.

B. Specification Language: Specifications and notes are written in imperative and abbreviated form. Imperative language of the technical specifications is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting “shall”, “shall be”, “the Contractor shall”, and similar mandatory phrases by inference. The words “shall be” is supplied by inference where a colon (:) is used within product specifications.

C. Drawings and Specifications:

1. Contractor shall be provided a digital copy of the Drawing Set and Specifications for his use.
2. Contractor shall carefully study the Drawings and Specifications, and shall at once report any error, unforeseen circumstances, inconsistency or omission upon discovery.
3. The Santa Ana College (SAC) Project Manager shall be the interpreter of the requirements of the Drawings and Specifications, subject to the final approval of SAC.

D. Intent and Correlation:

1. The intent of the Project Drawings and Specifications is to include all items necessary for the proper execution and completion of the Work.
2. The Project Drawings and Specifications are complementary, and what is required by any one shall be as binding as if required by both.

1.3 REFERENCES

A. Submit the project and customer information of customers for at least three other projects of similar size and complexity using similar technologies.

1. Shall include a minimum of the following:
   a. Customer Name
   b. Customer Point of Contact
   c. Customer Point of Contact Phone Number and email address
   d. Address of project
   e. Title of Project
   f. Type of project completed

B. Submit the technician certifications for the proposed access control system obtained or renewed within one year of RFP due date.

1. Shall include a minimum of the following:
   a. Two installation technicians employed by the Contractor.

b. One project manager employed by the Contractor.

1.4 DEFINITIONS

A. Industry standard words and phrases are used throughout the Drawings and Specifications, except:
   1. Words which have well-known technical or trade meanings are used in accordance with such recognized meanings.
   2. Whenever the following listed words and phrases are used, they shall be mutually understood to have the following respective meanings:

B. The words “as indicated.” means: as shown on the Drawings, and in accordance with the Specifications.

C. The words “as required.” means: as required to provide a complete and satisfactory Work in full conformance with the Drawings and Specifications.

D. The word “New” means: new Work to be provided by Contractor.

E. The word “Provide” means: furnish, install, connect, test and make ready for use.

F. The words “Relocate existing” means: remove existing item from present location. Reinstall, re-connect, and test existing item and make ready for use at new location as shown on the Drawings.

G. The words “Remove existing “means: remove existing item and return item to SAC**.**

H. The word “Replace” means: remove existing item and return item to SAC. Provide new item as indicated.

I. The word “Work”: The Work is the completed construction required by the Drawings and Specifications, and includes all labor necessary to produce such construction, and all materials and equipment incorporated or to be incorporated in such construction.

J. The word “Furnish” means: supply item as specified. Item to be installed by others.

1.5 CONTRACTOR DESIGN REQUIREMENTS

A. The Project Drawings represent the level of system design to be provided by SAC. Contractor shall provide all additional system design work required, including:
   1. Conduit layout and sizing.
   2. Wire and cable layout.
   3. Other detailed design work required.

B. Contractor’s design shall conform to all applicable codes and ordinances. All electrical design, including the sizing and placement of conduit, raceways and conductors, shall be in accordance with NFPA 70: National Electrical Code, current version, unless local codes establish more stringent requirements.

C. Contractor’s design work is subject to review and approval by SAC’s Project Manager.

D. Contractor’s design shall also include:
   1. The addition of all wire, cable, conduit, connectors and junction boxes required for system operation.
   2. The installation of conduit between the control components and all equipment at each door, as necessary.
   3. Completed “as-built” documentation of all security systems, including documentation of existing equipment, wiring, conduits, and raceways.
   4. Other Work as defined within the Project Drawings and Specifications.

1.6 PROFESSIONAL SERVICES (PSG)

A. Manufacturer shall provide Professional Services for direct end user support through the awarded contractor.
   1. All contractors shall provide Professional Services direct from the Manufacturer as follows:
      a. Bench Testing and Commissioning.
      b. Custom reporting.

c. Human Resource Integrations.
d. Conversions.
e. Third party integrations.
f. Disaster recovery commissioning testing .

B. Maintenance proposal should identify option for manufacturer provided Professional Services to include Life Cycle Management for ongoing system support
   1. Optional elements for support should include:
      a. Program Management regularly scheduled calls to include manufacturer, integrator and end user.
      b. Routine manufacturer audits and scheduled maintenance.
      c. Manufacturer provided annual upgrade services.

1.7 SUBMITTALS

A. Product Data: Product Data submittal shall only be required if the Contractor requests a substitution or a particular brand product is not specified or recommended.

B. Procedures
   1. Provide submittals to SAC's Project Manager.
   2. Submit three (3) copies of each submittal.

C. Shop Drawings
   1. General Shop Drawings for the project as described elsewhere.
   2. Provide other Shop Drawings only if specifically requested by SAC's Project Manager.

D. Manufacturers Installation and Programming Instructions
   1. Provide Manufacturers Installation and Programming Instructions as requested in the various Specification Sections.

E. Project Record Drawings
   1. Definition: Project Record Drawings are drawings that completely record and document all aspects and features of the Work. (Also known as "as-built" drawings.)
   2. The purpose of Project Record Drawings is to provide factual information regarding all aspects of the Work, to enable future service, modifications, and additions to the Work.
   3. Project Record Drawings are an important element of this Work. Contractor shall accurately maintain Project Record Drawings throughout the course of this project. Project Record Drawings shall include documentation of all Work, including the documentation of existing equipment, wiring, conduits, and raceways that are to be reused in the Work.
   4. SAC's Project Manager shall furnish Contractor with two (2) sets of site plans for Contractor's use in preparing Project Record Drawings. One set shall be used as a working set, the other shall be used to prepare the final record set.
   5. Contractor shall maintain the working set of Project Record Drawings at the project site throughout the course of the Work. The working set shall be updated on a daily basis as the Work progresses.
   6. Project Record Drawings shall accurately show the physical placement of the following:
      a. Equipment and devices.
      b. Conduit and raceways.
      c. Junction and pull box locations.
      d. End-of-line resistor locations.
      e. Interfaces to external equipment.
      f. Connections to power and telephone circuits.

F. Project Record Drawings shall show the physical placement of each device and conduit or aerial center line, to be accurate to within one foot (1') of the nearest landmark. Where the site plan furnished by SAC's Project Manager conflicts with actual conditions, Contractor shall amend site plan as required. Indicate exact description of conduit runs (above ground, two foot trench, along outside wall of building, etc.).

G. Project Record Drawings shall show wire and cable runs, zone numbers, tamper circuit configuration, panel/circuit breaker numbers from which equipment is powered, and splice points. Such information may be shown on the site plans.

H. Project Record Drawings shall be available for inspection by SAC's Project Manager on a daily basis. Incomplete or inaccurate Project Record Drawings may be cause for delay of Contractor's payment.

I. Upon completion of Work, and prior to Final Acceptance, Contractor shall prepare and submit to SAC Project Manager a final record set of Project Record Drawings. This set shall consist of all data transferred from the working set, supplemented by Riser Diagrams and other information. The final record set of Project Record Drawings shall be drafted by a skilled draftsperson, under the supervision of Contractor. All final Project Record Drawings shall be provided to SAC**.**

J. System Documentation

1. Definition: System Documentation is a complete collection of all installation, programming, operation, and maintenance manuals and work sheets relating to the equipment provided as part of the Work.
2. Contractor shall maintain a file of System Documentation at the project site throughout the course of the Work. Such file shall be updated with new information as equipment is received and installed. System Documentation shall be available for inspection by SAC Project Manager on a daily basis.
3. Upon completion of Work, and prior to final Acceptance, Contractor shall prepare and submit to SAC Project Manager three (3) sets of System Documentation.

K. Closeout Submittals

1. Provide a set of as-built drawings and manuals to the SAC Project Manager
   a. As-Built Drawings
   b. Mounting Details
   c. Product Data
   d. Installation Manuals
   e. Operating Manuals
   f. Maintenance/Service Manuals
2. Provide the SAC Project Manager- with all programming sheets, keys to the equipment cabinets, as-built drawings, operating manuals, maintenance/repair manuals, spare fuses, all programming sheets and keys to the equipment cabinets, tools for tamper-resistant enclosures and tools for manual resetting devices.

1.8 QUALITY ASSURANCE

A. Qualifications of Contractor

1. Contractor shall be an installation and service contractor regularly engaged in the sale, installation, maintenance and service of access control systems.
2. Contractor shall have three years' experience with the installation, start-up and programming of systems of a similar size and complexity to the one proposed.
3. Contractor shall be a factory authorized dealer of the system proposed for at least two years.
4. Contractor shall provide factory certified technicians to perform the installation of all intelligent controller components in this project. Evidence of the certification shall be in writing from the manufacturer and shall be on the technician's person at all times while on site.

B. Supervision of Work

1. Contractor shall employ a competent Foreman to be in responsible charge of the Work. Foreman shall be on the project site daily during the execution of the Work.
2. Contractor's Foreman shall be a regular employee, principle, or officer of Contractor, who is thoroughly experienced in projects of a similar size and type. Contractor shall not use contract employees or Subcontractors as Foremen.

C. Qualifications of Technicians

1. All electronic systems Work shall be performed by electronic technicians thoroughly trained in the installation and service of specialty low-voltage electronic systems.
2. Journeyman Wireman electrical workers may be used to install conduit, raceways, wiring, and the like, provided that final termination, hook-up, programming, and testing is performed by a qualified electronic technician, and that all such Work is supervised by the Contractor's Foreman.

3. All incidental Work, such as cutting and patching, lock hardware installation, painting, carpentry, and the like, shall be accomplished by skilled craftsperson's regularly engaged in such type of work. All such Work shall comply with the highest standards applicable to that respective industry or craft.
4. All 120 VAC power wiring and connections are to be performed by a qualified Journeyman Wireman, licensed to perform such Work in the SAC**.**

D. Subcontractors

1. Definition: A Subcontractor is a person or entity who has a direct contract with the Contractor to perform any of the Work at the site.
2. Use of any Subcontractor is subject to the approval of SAC. The Contractor shall identify all Subcontractors on the Bid Form. The Contractor shall make no substitution for any Subcontractor previously selected without approval from SAC**.**
3. Contractor's Foreman shall be on the project site daily during all periods when Subcontractors are performing any of the Work. Contractor's Foreman shall be in responsible charge of all Work, including any Work being performed by Subcontractors.
4. By an appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by the terms of the Drawings and Specifications, and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by these documents, assumes toward SAC**.**

E. Supervision and Construction Procedures

1. The Contractor shall supervise and direct the Work, using his best skill and attention. Contractor is solely responsible for all construction means, methods, and techniques.
2. The Contractor shall employ a competent foreman who shall be in attendance at the project site during the progress of the Work. The foreman shall represent the Contractor and all communications given to the foreman shall be as binding as if given to the Contractor.

F. Regulatory Requirements

1. All Work is to conform to all building, fire, and electrical codes and ordinances applicable in the SAC. In case of conflict between the Drawings/Specifications and codes, the codes shall govern. Notify SAC Project Manager of any such conflicts.
2. Contractor shall secure and pay for all licenses, permits, plan reviews, engineering certifications, and inspections required by regulatory agencies. Contractor shall prepare, at Contractor's expense, any documents, including drawings that may be required by regulatory agencies.

G. Permits

1. The Contractor shall make application for and obtain any and all permits required by federal, state, county, city, or other authority having jurisdiction over the work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Security of Contractor's Tools and Equipment: SAC is not responsible for the care, storage or security of any of the Contractor's tools or equipment.

1.10 PROJECT/SITE CONDITIONS

A. Environmental Conditions

1. Power: Electrical power will be supplied by SAC to the extent that the usage is compatible with available facilities in the vicinity of the work.
2. Telephone: Contractor may use a telephone designated by SAC for local and toll-free calls. The costs of long distance calls are the responsibility of the Contractor and shall not be charged to SAC**.**
3. Rest room Facilities: Contractor may use existing Rest room facilities designated by SAC**.**
4. Parking: SAC reserves the right to limit or restrict Contractor parking based upon the daily requirements of the other contractors on site.
5. Dust Control: Make provisions to control all dust, dirt, and foreign material caused by the performance of the Work.
6. Use of explosive type fastening equipment is prohibited.

7. Notify SAC immediately of any damage or possible damage to any other equipment.

B. Clean-Up
   1. Contractor shall clean-up, on a daily basis as the Work progresses, all dirt, dust and debris caused by Contractor's operations. Clean-up shall be completed by the end of each workday to the satisfaction of SAC's on-site representative.
   2. In the event that Contractor fails to clean-up, SAC may elect to have clean-up performed by others, with the costs of such clean-up being charged to the Contractor.

C. Construction Aids
   1. Definition: Construction Aids are facilities and equipment required by personnel to facilitate the execution of the Work. Construction Aids include scaffolds, staging, ladders, platforms, hoists, cranes, lifts, trenchers, core drillers, protective equipment, and other such facilities and equipment.
   2. Contractor shall provide all Construction Aids required in the execution of the Work. Construction Aids that are the property of SAC or other contractors shall not be used without permission.
   3. Storage of Construction Aids shall be coordinated with SAC's on-site representative.

D. Safety
   1. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work.
   2. Contractor shall comply with all local, state, and federal regulations and laws for the safety of the work place.

E. Accident Reports
   1. Serious or fatal accidents shall be reported immediately by telephone or radio to the **SAC**'s Project Manager.

F. Existing Conditions
   1. SAC does not warrant the condition of any portion of the existing wiring, conduit or raceway systems. Prior to submitting his proposal, Contractor shall examine all existing conditions and determine to what extent the existing wiring, conduit, and raceway systems may be reused.
   2. Contractor's proposal price shall include the cost of replacing existing wiring, conduit, and raceways as required.

1.11 SEQUENCING

A. Description
   1. This implementation plan describes the general approach that shall be followed in order to minimize the time for the access control systems to be operational.

B. Approach
   1. Contractor shall plan and schedule all work in such a sequence as to minimize the time before the system is operational. The following is a suggested work sequence:
      a. Order all equipment needed and notify any subcontractors to schedule their participation.
      b. Perform all system layout work.
      c. Insure there are an adequate number of power receptacles available to operate all security equipment and coordinate with SAC as to where power is available.
      d. Provide shop drawings to verify location of all equipment, conduit runs, power connections, etc. Submit shop drawings to SAC Project Manager.
      e. Coordinate with SAC to provide space in each building's Communications Room for mounting of processors.
      f. Provide training on how to fill out the programming sheets for access levels.
      g. Prepare and pre-test all equipment to the greatest extent possible.
      h. Install all equipment.
      i. Provide training on the programming other various options.
      j. Test and inspect all systems.
      k. Perform all other Work as required.
      l. Perform the Acceptance Test.
      m. Provide training.

n. Provide as-built drawings.

1.12 SCHEDULING

A. The Contractor, within five (5) days after being awarded the contract, shall prepare and submit for SAC's information, an estimated progress schedule for the Work. The progress schedule shall be related to the entire project, and shall indicate start and completion dates.

1.13 WARRANTY

A. Contractor warrants that all Work furnished (material and labor) under this Contract will be of good quality, free from faults and defects, and in conformance with the Project Drawings and Specifications.

B. Contractor shall provide a parts and labor guarantee on all Work. Unless otherwise specified herein, Contractor's guarantee shall be for a period of two (2) years from date of Acceptance, except where any specific guarantees from a supplier or equipment manufacturer extends for a longer time.

C. Contractor's guarantee shall cover all costs associated with troubleshooting, repair, and replacement of defective Work, including costs of labor, transportation, lodging, materials, and equipment.

D. Guarantee shall not cover any damage to material or equipment caused by accident, misuse, unauthorized modification or repair by SAC, or acts of god.

E. Contractor shall promptly respond to SAC's requests for service during the guarantee period. Contractor shall provide repair service as soon as reasonably possible upon request from SAC, but in no case shall service response exceed 8 hours from time of request.

1.14 SYSTEM STARTUP

A. Power shall only be applied to the system after re-checking for proper grounding of the system and measuring all loops for lack of shorts, grounds, and open circuits.

1.15 OWNER'S INSTRUCTIONS

A. Coordination with SAC

1. Contractor shall closely schedule and coordinate his activities with designated SAC representatives.
2. Contractor shall provide SAC's Project Manager with a work plan on a weekly basis. Such work plan will describe locations of intended activities, types of activities, and potential conflicts to facility operations.

B. SAC's Representatives

The following is SAC's designated representative:

1. PROJECT MANAGER
   SAC's Right to Carry out the Work
2. If the Contractor defaults or neglects to carry out the Work in accordance with the Project Drawings and Specifications and fails within seven days after receipt of written notice from SAC to commence and continue correction of such default or neglect with diligence and promptness, SAC may, after seven days following receipt of an additional written notice and without prejudice to any other remedy SAC may have, make good such deficiencies. In such case, an appropriate Change Order shall be issued deducting from the payments then or thereafter due the Contractor the cost of correcting such deficiencies.

C. Minor Changes in the Work

1. SAC shall have the authority to order minor changes in the Work not involving an adjustment in the Contract Sum or an extension of the Contract Time and not inconsistent with the intent of the Project Drawing and Specifications. Such changes shall be provided by written order.

1.16 COMMISSIONING

A. Manufacturer shall provide the opportunity for Professional Services to assist Contractor with commissioning.

B. After all Work is completed, and prior to requesting the Acceptance test, Contractor shall conduct a final inspection, and pre-test all equipment and system features. Contractor shall correct any deficiencies discovered as the result of the inspection and pre-test.

C. Contractor shall submit a request for the Acceptance test in writing to the SAC Project Manager, no less than fourteen days prior to the requested test date. The request for Acceptance test shall be accompanied by a certification from Contractor that all Work is complete and has been pre-tested, and that all corrections have been made.

D. During Acceptance test, Contractor shall demonstrate all equipment and system features to SAC. Contractor shall remove covers, open wiring connections, operate equipment, and perform other reasonable work as requested by SAC.

E. Any portions of the Work found to be deficient or not in compliance with the Project Drawing and Specifications will be rejected. SAC Project Manager will prepare a list of any such deficiencies observed during the Acceptance test. Contractor shall promptly correct all deficiencies. Upon correction of deficiencies, Contractor shall submit a request in writing to SAC Project Manager for another Acceptance Test.

F. If, at the conclusion of the Acceptance Test, all Work is found to be acceptable and in compliance with the Project Drawings and Specifications, SAC Project Manager will issue a letter of Acceptance to Contractor and SAC.

1.17 MAINTENANCE

A. Provide full procedures for all database back-ups.

B. Provide full procedures for server/workstation hard drive maintenance, such as defrag, etc.

C. Provide full procedures for maintaining physical and software firewalls.

D. Provide full procedures for upgrading software.

E. Provide full procedures for testing battery condition on all field panels for adequate back-up time.

F. Provide full procedures for any other tasks that must be performed to ensure the warranty remains intact.

PART 2 PRODUCTS

2.1 GENERAL

A. All products not provided by SAC shall be new and unused, and shall be of manufacturer's current and standard production.

B. Where two or more equipment items of the same kind are provided, all shall be identical and provided by the same manufacturer.

C. Drawings and Specifications indicate major system components, and may not show every component, connector, module, or accessory that may be required to support the operation specified. Contractor shall provide all components needed for complete and satisfactory operation.

D. Product Availability

1. Contractor, prior to submitting a proposal, shall determine product availability and delivery time, and shall include such considerations into his proposed Contract Time.
2. Certain products specified may only be available through factory authorized dealers and distributors. Contractor shall verify his ability to procure the products specified prior to submitting a proposal.

E. Wire and Cable

1. General: Provide all wire and cable required to install systems as indicated. Wire and cable shall be sized to provide minimum voltage drop and minimum resistance to the devices being supplied.
2. All cables shall be specifically designed for their intended use (direct burial, aerial, etc.).
3. Comply with equipment manufacturers recommendations for wire and cable size and type.
4. Comply with all applicable codes and ordinances.

F. Conduit and Raceway Systems
1. General: The placing of surface mounted conduit on the exterior of any building shall be approved by SAC prior to its installation.
2. Interior Conduit:
   a. Electrical Metallic Tubing (EMT)
   b. Flexible Metal Conduit
   c. Provide fittings and connectors as required for installation of EMT or flexible conduit.
3. Surface Raceways:
   a. Sheet metal channel with fitted cover, suitable for use as surface metal raceway, WIREMOLD or approved equal.
   b. Provide fittings, elbows, and connectors designed for use with raceway system.
4. Exterior Conduit: (any of the following as determined by local code requirements):
   a. Rigid Steel Conduit
   b. Rigid Aluminum Conduit
   c. Rigid Nonmetallic Conduit (only if buried 18" below ground surface).
   d. Intermediate Metal Conduit
   e. Provide rain-tight fittings and connectors as required for installation of exterior conduit.
5. Exterior Flexible Conduit:
   a. Liquidtight Flexible Conduit: Flexible metal conduit with PVC jacket.
   b. Provide rain-tight fittings and connectors as required for installation of Liquidtight Flexible Conduit.

G. Junction and Pull Boxes
1. Interior Boxes: Sheet Metal Outlet Boxes: Sizes to be determined in accordance with code requirements for conductor fill. No box shall be smaller than a single gang 1-1/2 deep. Provide box covers as required.
2. Exterior Boxes: All exterior boxes shall NEMA 4 or NEMA 3R, watertight and dust-tight
3. All interior and exterior boxes shall have their covers fastened using security screws.

H. Lightning Protection
1. The Contractor shall provide suitable lightning protection for all processors/controllers.
2. All lightning protection equipment shall be UL listed.

2.2 MANUFACTURERS

A. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

B. Security Management System Manufacturer: Pro-Watch Security Management Suite as manufactured by the Honeywell Security Group.

C. The Security Management System shall function as an electronic access control system and shall integrate alarm monitoring, CCTV, digital and network video, ID badging and database management into a single platform. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions.

D. Access Control Software Suite: The Security Management System shall offer a security management software suite available in four scalable versions: The Security Management System platform shall offer a complete access control solution: alarm monitoring, video imaging, ID badging and video surveillance control. Provide the following software system:

E. Pro-Watch Professional Edition. Professional Edition: The Security Management System shall utilize Microsoft SQL Express (SQL 2008 or later) database for applications from one to five users and up to 64 controlled doors. The Security Management System shall provide a set of tools to easily backup, restore and maintain the Security Management System database. The Security Management System shall allow for expansion to Corporate and/or Enterprise Edition without changing the user interface or database structure. The Security Management System shall operate in Windows 7 Ultimate/Professional as the host operating system.

F. Pro-Watch Corporate Edition: The Security Management System shall operate in the Windows Server 2012 (64-bit) and Windows Server 2012 R2 (64-bit) environment and utilize SQL Server 2012 SP1 (32-bit and 64-bit) as the database engine.

G. Software Requirements: The Security Management System shall be a modular and network-enabled access control system. The Security Management System shall be capable of controlling multiple remote sites, alarm monitoring, video imaging, ID badging, paging, digital video and CCTV switching and control that allows for easy expansion or modification of inputs and remote control stations. The Security Management System control at a central computer location shall be under the control of a single software program and shall provide full integration of all components. It shall be alterable at any time depending upon facility requirements. Security Management System reconfiguration shall be accomplished online through system programming. The Security Management System shall include the following:

H. Multi-User/Network Capabilities: The Security Management System shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall automatically generate alarm messages when the server is unable to communicate with a workstation. The operators on the network server shall have the capability to log on to workstations and remotely configure devices for the workstation. Standard operator permission levels shall be enforced, with full operator audit.

I. Concurrent Licensing: The Security Management System shall support concurrent client workstation licensing. The Security Management System application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the database server as long as the maximum number of concurrent connections purchased has not been exceeded.

J. Security Key: The Security Management System shall only require a software security key to be present on the application server for the Security Management System to operate. Security keys shall not be required at the client workstations. The Security Management System shall allow a user to read the information that is programmed on the server security key. The Security Management System shall support the installation, update, and termination of the security key.

K. Terminal Services: The Security Management System shall support Windows Server 2008 Terminal Services. Terminal Services shall allow the Security Management System server application to reside on the Windows Terminal Server. Operating systems supporting a standard web browser shall be capable of utilizing the thin client architecture. The Security Management System shall support unlimited connections, based on concurrent licensing, to the Security Management System software. Full functionality shall be obtained through the intranet connection allowing full administration and monitoring without the need for a local installation.

L. Relational Database Management System: The Security Management System shall support industry standard relational database management systems. This shall include relational database management system Microsoft SQL Server 2012 SP1.

M. Database Partitioning: The Security Management System shall provide the option to restrict access to sensitive information by user ID.

N. Memory: Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in read-only memory.

O. LDAP/ Microsoft Active Directory Services: The Security Management System shall provide support of Lightweight Directory Access Protocol (LDAP) for enabling the user to locate organizations, individuals, and other resources such as files and devices in a network, whether on the public internet or on a private intranet. The Security Management System shall provide a direct link to Microsoft Active Directory Services. The Security Management System shall allow the transfer of Active Directory users into the database via the Data Transfer Utility. Conversely, Security Management System users shall be capable of being exported to the Active Directory.

P. Unicode: The Security Management System shall utilize Unicode worldwide character set standard. The Security Management System shall support double-byte character sets to facilitate adaptation of the Security Management System user interface and documentation to new international markets. Language support shall include at a minimum English, Spanish, Portuguese, French, German and Simple Chinese.

Q. Encryption: The Security Management System shall provide multiple levels of data encryption

1. True 128-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Security Management System based on a successful match.
2. Transparent database encryption, including log files and backups
3. SQL secure connections via SSL

R. Supervised Alarm Points: Both supervised and non-supervised alarm point monitoring shall be provided. Upon recognition of an alarm, the system shall be capable of switching CCTV cameras that are associated with the alarm point.

S. Compliance and Validation: The Security Management System shall incorporate signature authentication where modifications to Security Management System resources will require either a single or dual signature authentication. Administrators will have the ability to select specified devices in the Security Management System where data manipulation will be audited and signatures will be required to account for the data modification. Upon resource modification, the user will be required to enter a reason for change or select a predefined reason from a list. All data will be securely stored and maintained in the database and can be viewed using the reporting tool. This functionality will meet the general requirements of Validation and Compliance through Digital Signatures with special attention to the case of Title 21 CFR Part 11 Part B compliance.

T. Clean Room Solution:

1. Overview: The Security Management System shall provide a clean room solution which enables users to manage their "Clean Environments" or other areas requiring special restricted access through a process-oriented graphical user interface (GUI).
2. Configuration: The user shall have the capability of adding, editing, or deleting clean rooms. Each "clean room" shall be capable of having a contamination level set. Entry to a higher level contamination area shall automatically restrict access to cleaner level areas. Individual cards shall be capable of being reset on an immediate one time, automatic, or per-hour basis.

2.3 SECURITY MANAGEMENT SYSTEM OPERATIONAL REQUIREMENTS:

A. System Operations:

1. Windows Authentication Login: The Security Management System shall use an integrated login method which accepts the user ID of the person who has logged on to Windows.
2. Password: The Security Management System shall use an integrated authentication method which utilizes Windows user accounts and policies.
3. Information Access: The Security Management System shall be capable of limiting operator access to sensitive information. Operators shall have proper authorization to edit the information.
4. Shadow Login: The Security Management System shall allow users to login over a currently logged-on user without having the current user log off the Security Management System or out of the Windows operating system.
5. Graphical User Interface: The Security Management System shall be fully compliant with Microsoft graphical user interface standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.

6. Guard Tour: The Security Management System shall include a guard tour module, which shall allow the users to program guard tours for their facility. The tours shall not require the need for independent or dedicated readers.
7. Secure Mode Verification (e.g., force guard to do a visual verify): The Security Management System shall provide ' secure mode' control from the verification viewer. This shall allow a user or guard to decide the access of an individual who presents his/her card at a designated secure mode reader.
8. Database Partitioning: The Security Management System shall support dynamic partitioning. A Security Management System in which partitions are set up at installation and cannot be easily changed shall not be acceptable.
9. Status Groups: The Security Management System shall support a real-time system status monitor that graphically depicts all logical devices.
10. Keyboard Accelerators: The Security Management System shall allow the user to use a shortcut key to enable designated system commands.
11. Automatically Disable Card upon Lack of Use: The Security Management System shall allow system operators to set a predefined time period in which cardholders shall swipe their card through a card reader in the Security Management System.
12. User Functions and ADA Ability: The Security Management System shall provide user functions and ADA (Americans with Disabilities Act) ability that provides the capability to trigger an event at the Security Management System intelligent controller when a defined card is presented.
13. Pathways: The Security Management System shall support the capability of programming pathways. A pathway shall be an object that combines input points to be masked (shunted) for a set duration, and an output point to be activated, when a particular card receives a local grant at a reader.
14. Database Audit Log: The Security Management System shall be capable of creating an audit log in the history file following any change made to the Security Management System database by an operator.
15. Operator Log: The Security Management System shall be capable of creating an action log in the history file following actions performed by an operator.
16. Alarm Routing: The Security Management System shall be capable of defining routing groups that determine what event information shall be routed to a user or class of users.
17. Global and Nested Anti-passback: The Security Management System shall support the use of an optional anti-passback mode, in which cardholders are required to follow a proper in/out sequence within the assigned area.
18. Two Person Rule: The Security Management System shall support a "two person rule" to restrict access to specific access areas unless two cardholders present two different valid cards to the reader one after the other within a period time defined by the door unlock time multiplied by a factor of 2.
19. Occupancy Restrictions: The Security Management System shall allow the user to define the minimum and maximum occupancy allowed in a designated area.
20. Multiple Sequential Card Swipes to Initiate Procedure: The Security Management System shall allow the user to define a logical device, quantity of consecutive identical events, a time period and a Security Management System procedure to trigger when the event occurs a maximum quantity of times in the allocated time period.
21. Hardware Templates: The Security Management System shall include the ability to define hardware templates (door templates) in order to simplify the process of creating an access control system. Hardware templates shall allow a user to define a "typical" door configuration and then use that template over and over in the process of defining doors.

B. Access Control Functional Requirements: Functions shall include validation based on time of day, day of week, holiday scheduling, site code verification, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card/PIN, card, and video. The following features shall be programmable and shall be capable of being modified by a user with the proper authorization:
    1. Time Zones: Shall define the period during which a reader, card, alarm point, door, or other system feature is active or inactive. In addition to Monday-Sunday, there shall be at least one day of the week called Holiday.
    2. Holidays: The application shall allow holidays to be entered into the Security Management System. Holidays shall have a start date plus duration defining multiple days. Holidays shall have a holiday type of 1, 2, or 3, which may be defined by the user.

3. Response Codes: The Security Management System shall allow the user to enter a predefined code to represent a response to an alarm occurring in the facility.
4. Clearance Codes: The Security Management System shall allow the user to establish groups of readers at a facility for the purpose of granting or denying access to badge holders. Clearance codes shall be assigned to companies and individuals employed by the company, and may be modified for individual users in the badge holder maintenance application.
5. Companies: Each badge holder entered into the Security Management System shall be assigned a company code identifying the individual's employer. The company information dialog box displays and maintains information related to companies having access to the facility.
6. Group Access: The Security Management System shall allow a user or group of users via company selection, a temporary denial of access to specific readers or areas based on a preconfigured event. The group access function shall limit access to a group of cardholders, overriding all other access criteria.
7. Event Types: Definitions shall be shipped with system software but shall be capable, upon installation, of being modified, added to, or deleted from the Security Management System.
8. Alarm Pages: Security Management System shall include the capability to create an unlimited number of customized alarm pages for the alarm monitor and each shall be assignable to users and user classes.
9. Event Types: Definitions shall be shipped with system software but shall be capable, upon installation, of being modified, added to, or deleted from the Security Management System.
10. Dynamic Graphical Maps: The Security Management System shall provide the user with the means to add maps and indicator icons to maps that shall represent input/output points, logical devices, or cameras located throughout the Security Management System. Security Management System maps shall display the state and condition of alarm points. The Security Management System shall also provide the ability to monitor the channels or panels.
11. Brass Keys: Shall maintain information related to assets that are issued in the facility, including brass keys, laptops, RSA keys, cell phones, company cards, etc.
12. ID Badging Client: The Security Management System Shall maintain information related to a badge holder's card access privileges. Upon entering this application, a window shall appear on the screen and all actions (add, modify, or delete) involving badges and cards shall be initiated from this window. Access privileges shall be linked to the cards used to gain access to doors in the facility. Modifications shall be made by adding or deleting clearance codes, or by door types assigned to the cards or to a badge holder.
13. ID Badging System: The Security Management System shall include seamlessly integrated ID badging system.
14. Users: Information related to the users of the Security Management System software shall be stored in the database. Users entered into the Security Management System shall be assigned the access privileges of the class to which they are assigned.
15. Elevator Control: The elevator control shall be of the Security Management System intelligent controller-based line of devices. The elevator control shall include the following functional features:
    a. Elevator call: Valid card read calls elevator to the floor. No reader in the elevator car.
    b. Floor control: Valid card read in the elevator car enables selectable floor buttons.
    c. Floor select: Valid card read in the elevator car enables selectable floor buttons and logs which floor is selected after the card is presented.
16. Data Transfer Unit (DTU): The DTU enables data to be imported from an external system directly into the Security Management System database and also exported from Pro-Watch to an external system.
    a. Insert only: If a "data file key column #" shall be provided, the DTU will only insert a new badge record if the key column value is not found. An error shall be displayed in the log file if an existing badge record is found. If no "data file key column #" is provided, every record will be inserted into the Security Management System.
    b. Updates only: The DTU shall use the "data file key column #" to look for the matching Security Management System record. An error shall be logged in the log file if the badge holder is not found in the Security Management System database.
    c. Inserts, updates: The DTU shall use the "data file key column #" to look for the matching Security Management System record. If a matching record is not found, the DTU shall insert the data. If a matching record is found, the record shall be updated.

17. Generic Channel Interface: The Security Management System shall provide the ability to define generic communications channels over serial port or TCP/IP network socket including IP address and port/socket, to support custom integration of external foreign devices. The Security Management System shall generate events based on data received from the channel matching operator pre-defined instructions.

C. Application Localization: The Security Management System shall support at least seven languages including English. The languages available shall include German, French, Spanish, Italian, Chinese (simplified), Portuguese (Brazil), Norwegian, Chinese (Traditional), Danish, and Dutch, All database resources will be localized, and will include a standard U.S. English help file.

D. Event Manager: The Security Management System shall utilize an event manager as a component of system administration and offer the ability to have users control the amount of data stored as well as a quick snapshot of the logged data in the system. Using the various logs in event manager, the user will be able to gather information about events, auditing, and operator actions. The logs are defined as follows: Event log, audit log, unacknowledged alarms.

2.4 INTELLIGENT CONTROLLERS - HARDWARE REQUIREMENTS:

A. Distributed architecture shall allow controllers to operate independently of the host. The architecture shall place key access decisions, event/action processing and alarm monitoring functions within the controllers, eliminating degraded mode operation.

B. Flash memory management shall support firmware updates and revisions to be downloaded to the system. Upgrades to the hardware and software shall occur seamlessly without the loss of database, configurations, or historical report data.

C. Manufacturers: Subject to compliance with requirements, provide Field Controllers or comparable product by one of the following:

1. Honeywell Security PW-6000
2. Honeywell Security PW-6101ICE
3. Honeywell Security Star II(Legacy)
4. Honeywell Security PW-2000(Legacy)
5. Honeywell Security PW-3000
6. Honeywell Security PW-5000

2.5 FIELD HARDWARE:

A. The security management system shall be equipped with access control field hardware required to receive alarms and administer all access granted/denied decisions. All field hardware shall meet UL requirements.

1. Intelligent Controller Board:
   a. PW3K1IC (Legacy Only).
   b. PW6K1IC.
   c. PW6K1ICE.
2. Single Reader Module (SRM):
   a. PW6K1R1.
   b. PW6K1R1E.
3. Dual Reader Module (DRM):
   a. PW6K1R2.
4. Alarm Input Module (AIM):
   a. PW6K1IN.
5. Relay Output Module (ROM):
   a. PW6K1OUT.
6. Mercury Family Hardware:
   a. EP-1501.
   b. EP-2500 with Wiegand Reader.
   c. MR-16IN (16 Input Board).
   d. MR-16OUT (16 Output Board).
   e. MR-50 (Single Reader Board).
   f. MR-51E (Single Reader Board ETHERNET).
   g. MR-52 (2-Reader Board).

h. SCP/SCP2.
i. SCPC.
j. Mercury M5 Bridge.

7. Card Readers:
   a. HID:
      1) iCLASS R10 (wall mount) & R40 (mullion mount)

2.6 SOFTWARE DEVELOPMENT KIT (SDK)

A. Security Management System shall permit custom integration with other third party systems through an SDK. SDK shall support the OBIX communication protocol and interface directly with the Niagara Framework for support of additional communications protocols.

B. Manufacturer and part numbers:
   1. Honeywell Security HSDK.

2.7 WEB CLIENT:

A. Web Alarms.

B. Web Events.

2.8 SUPPORTED WEB BROWSERS:

A. (Windows) Internet Explorer latest version.

B. (Windows) Google Chrome latest version.

C. (Windows) Firefox latest version.

2.9 INTEGRATED SECURITY MANAGEMENT SYSTEM

A. Product: WIN-PAK Access System as manufactured by the Honeywell Security Group.

B. The Integrated Security Management System (ISMS) shall function as an electronic access control system and shall integrate the alarm monitoring, CCTV, digital and network video, ID badging and database management into a single platform. ISMS shall function as a one-stop gateway for all the access control needs. A modular and network-enabled architecture shall allow maximum versatility for tailoring secure and dependable access and alarm monitoring solutions. The ISMS shall offer a security management software suite that includes all the features bundled in the following three editions:

C. Professional Edition (PE): Shall include all the features of Standard Edition plus the following additional features: Unrestricted concurrent users, multiple communication servers, 255 IP connections per communication server, 100,000 card holders and PRO3200, PRO2200, NetAXS-123, NetAXS-4, N1000/PW2000, NS2 and NS2+ panel support.

2.10 ISMS COMPONENTS:

A. The ISMS shall be divided into three components: Database Server, Communication Server, and User Interface. These components shall run on a single computer or on multiple computers, allowing flexibility in configuring a networked system.
   1. Database Server: The database server is used for storing the database tables. This data is accessible to communication server and user interface for retrieving and generating the reports. The database server shall be installed on the client computer or any other computer connected to the network.
   2. Communication Server: The communication server routes user interface requests as well as the access transactions to the panel. The panel in-turn processes the transactions and sends the information to the database server as well as responses to the user interface through the communication server. When the communication server is sending information to the database server, it can also receive a request from the user interface. In this scenario, the communication server considers the user request as a higher priority and stops the panel-database server communication until the user request is processed. The communication server shall be installed on the client computer or any other computer connected to the network.

3. User Interface (ISMS Client): The user interface helps ISMS operators to communicate with the access control system. The user interface shall be installed on the computer where the database server or the communication server is installed or any other computer connected to the network. Several client computers can be run simultaneously and can access the single database server simultaneously. The number of client computers varies based on the licensing information of ISMS.

B. The ISMS includes the Command File Server: A command file server provides text files containing device instructions that shall be stored in the command files database. The commands in the command files can be sent to the devices automatically on receiving, acknowledging, or clearing an alarm. Also, the command files can be manually executed.
   1. Guard Tour server: A guard tour is a defined series of check points a guard must activate within a given amount of time. The check points are readers or input points where the guard presents the card or presses the button.
   2. Tracking and Muster Server: A muster server is enabled in the event of an emergency and allows the card holders to swipe the readers. Muster areas are logical areas that contain readers to be used by the card holders, only if there is a call for muster (in the event of a disaster, for example).
   3. Schedule Server: A schedule server schedules the list of events to be performed at a predetermined time and intervals such as hourly, daily, or monthly.
   4. Video Management Server: A video management server provides interface to connect to various DVR's/NVR's. In addition, it also provides CCTV control with live monitor display, PTZ control of cameras and video playback operations.

2.11 INTEGRATED SECURITY MANAGEMENT SYSTEM OPERATIONAL REQUIREMENTS:

A. The ISMS shall be a modular and network-enabled access control system capable of controlling multiple remote sites, alarm monitoring, video imaging, ID badging, paging, digital video and CCTV switching and control that allows for easy expansion or modification of inputs and remote control stations. The ISMS control at a central computer location shall be under the control of a single software program and shall provide full integration of all components. It shall be alterable at any time depending upon facility requirements. The ISMS reconfiguration shall be accomplished online through system programming.

B. The ISMS application shall have the major functional capabilities (considered essential for the system) categorized as follows:
   1. General:
      a. All the databases shall have the ability to add, delete, report, view, and edit information.
      b. All the system transactions shall be saved in a retrievable file.
      c. All the events shall be logged by date and time.
      d. All the system transactions or selected system transactions shall be saved in a disk file.
      e. The end-user shall have the provision to make any system configuration changes such as, but not limited to door open time, door contact shunt time, point and reader names, when and where a cardholder is valid, and the ability to add or modify card databases at any time.
      f. Shall support "Global Anti-pass back", feature allowing cardholder to enter/exit any such defined card reader on the same intelligent control panel or RS-485 drop-line consisting of 2 and 4 door controllers.
      g. Anti-pass back modes shall include: hard (no forgiveness), soft (allows access but generates an alarm event) and timed for all readers on the intelligent controller, on specified reader or card for a definable period of time up to 32,000 seconds.
      h. Shall support the "Duress" feature, where a PIN is used in conjunction with a card read; the numbers of digits are selected using the keypad where the PIN number is a value different from the normal PIN.
      i. Shall support the "Two card holder" rule, where two valid, non-identical "cards" must be used within a 20 second period to grant access.
      j. Shall have the option to display the time when a card holder using a reader has accessed (opened) the door or the card was used, but the door was not opened.
      k. Shall support the "Latch mode" operation where the first card read unlocks the door and the second card read locks it.

l. Shall provide a mode of system operation that stores system commands not accepted by the hardware.
m. Shall provide a mode of system operation that requires the operator to enter a response to an event when acknowledging it from the alarm view window.
n. Shall provide a mode of system operation that allows acknowledged alarms to be automatically cleared.
o. Shall provide a mode of system operation where when an acknowledged, but not cleared event will be reissued requiring acknowledgement when the event changes to an alarm or trouble state.
p. Shall provide a mode of system operation that does not allow the operator to clear an alarm before prior to it being restored to normal.
q. Shall provide the ability for manual operator control of system output relays. The manual functions shall include the ability to energize, de-energize, return to time zone, or pulse the output relay. The pulse time shall be a programmable setting.
r. Shall provide the ability for manual operator control of system doors. The manual functions shall include the ability to Lock, Un-Lock, Disable, Card only, Card-Pin only, Pin only, exit only and site code only.
s. Shall provide the ability to automatically display stored "video image" of cardholder, and switch real-time camera from CCTV or digital video server to card reader location for specific card usage.
t. The cardholder "video image" pop-up shall be activated based on a priority level set to the cardholder or reader. Information in the pop-up shall include, but not be limited to the card holder's primary image a live video pop-up showing the person who initiated the pop-up, entrance name, time, date, cardholder name, and status. User shall be able to display up to 40 note fields. The size of the pop-ups shall be adjustable by the operator.
u. Shall support multiple card reader technology including: Proximity, Wiegand effect, Biometrics, Magnetic stripe, Bar Code, Keypad, Card/keypad (PIN), High-speed long range Vehicle ID, and Smart Card.
v. Shall provide an option for taking scheduled automatic backups of any or all database system files. A means to restore these files from a simple menu shall exist.
w. Shall provide the ability to address up to 255 serial communication ports per communication server, where each port can be configured for either hardwired, or dial-up. When configured for dial-up, any one port can support multiple dial-up locations.
x. Communication from the access control communication server to the remote intelligent control panels shall be selectable. Communication options shall be RS-232 directly to the intelligent control, via RS-485 converter, dial-up, leased line from a defined communication port or by LAN/WAN using an IP address for direct connection to the intelligent controller via network interface card. When using IP addressing it shall be un-acceptable to use a communication port converter device on the communication server side of the transmission. A minimum of 255 such IP connections shall be allowed per communication server.
y. All commands and updates to the panels shall be verified and shall automatically retry if communications fail.
z. Shall provide a system scheduler that shall automatically: Call remote locations to retrieve history transactions and update panel information, including time and date, Activate or deactivate cards locally or at remote dial-up sites, Initiate a pre-programmed command event/action, Synchronize system to intelligent controller time, Run a pre-defined (template) History report, Run a pre-defined (template) Card Holder report, Card frequency report defined by reader(s), over a defined period of time with disposition options to automatically report or report and de-activate card or change the access level of the card, Frequency shall be defined as Never, Now, Once, Hourly, Daily, and Weekly, Once per 2 weeks, and Monthly.
aa. Shall provide drop boxes for all system-required information that the user has previously entered.

bb. Shall provide the ability to initiate an email (via SMTP) or page to a paging system based on a transaction state. A transaction state shall be defined as but not limited to Normal, Alarm, Trouble, Ajar, Trace, Not Found, Anti-Pass back Violation, PIN Violation, Time Zone Violation, Site Code Violation, Door Used, Duress, No Second Card Presented, Trace Card or Expired Card, and System Alarms including, Panel Com, Panel Power Failure, Modem Pool, Guard Tour, and Tamper. Intrusion partition events including but not limited to: Alarm, Alarm Cancel, Aram Away, Arm Stay, Auto Arm, Auto Disarm, Bypass, Disarm, Early Arm, Early Disarm, Fail to Arm, Fail to Disarm, Normal, Not Ready, Part Arm, Quick Arm, Recent Close, Remote Arm, Remote Disarm, Unbypass, User Code Added, User Code Deleted, user Code Edited. Intrusion zone events including but not limited to: Alarm, Alarm Restore, Bypass, Fault, Fault Restore, Normal, Trouble, Trouble Restore, and Unbypass. Intrusion output events including but not limited to: Alarm, Communication Loss, Normal, Tamper, and Tamper Restore. Intrusion panel events including but not limited to: Access Denied, Automatic Test, Comm Fail, Comm Restore, Faults, Faults Restore, Line Restore, Line Trouble, Manual Test, Pager Restore, Pager Trouble, AC Restore, AC Trouble, Alarm, Battery Low, Battery Low Restore, Disarm, Normal, Recent Close, Reset, Panic Alarm, Power Up, Program begin, Program Changed, Program End, System Shutdown, System Shutdown Restore, Tamper Alarm, Tamper Restore, Test End, Test Start, Time/Date changed.

cc. Shall include a "host grant" mode of operation that requires the host computer to grant accesses to "valid" cards. An alternate host grant mode shall allow the card access information to be downloaded along with unlocking the door for "valid" cards.

2. Cards: Shall provide a simple card and card holder database import utility. The utility shall be password protected and accessible only to administrators of the access control system. Information that can be imported shall include but not be limited to: First Name, Last Name, Card Number, Activation Date, De-activation Date, Status, up to 40 note fields and Photo Images. A simple CSV (comma separated value) file shall be used for the importing of data and image file names.
3. Access Levels: Shall provide an option to define specific access times and specific readers for access. Shall provide a template of a defined access level detail, where changes can be made to the template and saved as a new access level detail.
4. Access Control Panels: Shall provide ability to program Action Messages and assign an alarm event priority. .
5. Reports: Shall provide Card holder report capability with filter options to define door(s) that a card holder has access to, reporting card holder name, Card(s), Access Level/schedules, Activation/Expiration.
6. Tracking/Muster Report: A tracking feature shall allow the system operator to identify an area and the person(s) in that area.
7. Time Zones: Time zone definitions shall include Starting time, Ending time, Days of the week, and Holiday override.
8. Floor Plan Graphic: Shall provide the ability to import floor plan graphics stored in a WMF format.
9. Remote Locations: Shall provide the ability to place remote control panels in an offline mode. In the offline mode, the remote control panels shall retain all panel history events. The amount of historical events shall be limited to the panels' buffer capacity.
10. Guard Tour: Guard Tour shall allow the operator to program a series of guard check points that must be activated to accomplish the task of a Guard Tour.
11. ID Badging System/Video Image System: Shall allow any card data fields to be assigned to a badge.
12. Networking: Shall provide networking capabilities (LAN or WAN) as allowed by the computer's operating system license.

2.12 ISMS HARDWARE AND SOFTWARE REQUIREMENTS:

A. The ISMS shall be installed in a computer that supports 1 to 10 readers, 250 cards, and 2 communication ports. The minimum hardware and software requirements to fulfill this installation are:

1. Processor: Dual Core Intel(R).
2. CPU: 2.4 GHz.
3. RAM: 2 Gigabytes (GB).

4. Hard Disk: 80 GB SATA with minimum 5 GB free space.
5. Serial Communication Ports: 2.
6. Secondary Storage: Tape or DVD burner.
7. Printer port: 1 (2 if badging).
8. Monitor Display: Size: 15 Inches SVGA, Resolution: 1024 x 768, Colors: 256.
9. Pointing Device: Mouse (USB preferred).
10. Operating System: Microsoft Windows 7 SP1.
11. Database: Microsoft SQL Server 2012 Express Edition.

B. The ISMS shall be installed in a computer that supports 1 to 100 readers, 5,000 cards, and 8 communication ports. The recommended hardware requirements to fulfill this installation are:

1. Processor: Quad Core Intel Xeon®.
2. CPU: 2.4 GHz.
3. RAM: 4 Gigabytes (GB).
4. Hard Disk: 250 GB SATA or SCSI.
5. Serial Communication Ports: 2.
6. Secondary Storage: Tape or DVD burner.
7. Printer port: 1 (2 if badging).
8. Monitor Display: Size: 17 Inches SVGA, Resolution: 1024 x 768, Colors: True color.
9. Pointing Device: Mouse (USB preferred).
10. Operating System: Microsoft Windows 7 SP1.
11. Database: Microsoft SQL Server2012 Express Edition.

C. The ISMS shall be installed in a computer that supports that supports more than 100 readers, 100,000 cards and 255 communication ports, The maximum/performance hardware requirements to fulfill this installation are:

1. Processor: Intel(R) Quad Core E5504 Xeon.
2. CPU: 2.4 GHz.
3. RAM: 8 Gigabytes (GB).
4. Hard Disk: Minimum 500 GB SATA 7200 RPM, recommended 15kRPM.
5. Serial Communication Ports: As per the requirement.
6. Secondary Storage: Tape or DVD burner.
7. Monitor Display: Size: 19 Inches SVGA, Resolution: 1280 x 1024, Colors: True color.
8. Pointing Device: Mouse (USB preferred).
9. Operating System: Microsoft Windows Server 2012 R2.
10. Database: Microsoft SQL Server2012 with processor/core license.

2.13 HARDWARE REQUIREMENTS:

A. Intelligent Controllers:

1. Distributed architecture shall allow controllers to operate independently of the host. The architecture shall place key access decisions, event/action processing, and alarm monitoring functions within the controllers, eliminating degraded mode operation.
2. Flash memory management shall support firmware updates and revisions to be downloaded to the system. Upgrades to the hardware and software shall occur seamlessly without the loss of database, configurations, or historical report data.
3. Manufacturers: Subject to compliance with requirements, provide Field Controllers or comparable product by one of the following:
   a. Honeywell NetAXS Controller (NetAXS-123 and NetAXS-4 are the two types of NetAXS controllers).
   b. Honeywell P-Series Controller (PRO-2200 (Legacy), PRO-3200 are the types of P-Series controllers).
   c. Intelligent Controller Board: Honeywell Security PRO32IC
   d. Honeywell N-1000 or PW-2000 Controller (Legacy only).
   e. Honeywell Security NS2 or NS2+ (Legacy only).

B. Field Hardware:

1. The security management system shall be equipped with access control field hardware required to receive alarms and administer all access granted/denied decisions. All field hardware shall meet UL requirements.

2. Intelligent Controller Board: Honeywell Security PRO32IC
3. Single Reader Module (SRM): Honeywell Security PRO22R1
4. Dual Reader Module (DRM): Honeywell Security PRO32R2
5. Alarm Input Module (AIM): Honeywell Security PRO32IN. 16 Inputs 2 Outputs.
6. Relay Output Module (ROM): Honeywell Security PRO32OUT. 16 Outputs 2 Inputs.
7. NetAXS-4 Access System as manufactured by the Honeywell Security Group
   a. NX4S1: 4 Door Control Panel (Standard Enclosure)
   b. NX4L1: Pre-wired 4 Door Control Panel (Deluxe Enclosure)
8. NetAXS-123 Access System as manufactured by the Honeywell Security Group
   a. NX1P: One-door compact (plastic) enclosure with tamper switch
   b. NX1MPS: One-door standard (metal) enclosure with tamper switch, power supply, and battery
   c. NXD1: One-door add-on board (to NX1P or NX1MPS) for two-door capacity
   d. NXD2: Two-door add-on board (to NX1P or NX1MPS) for three-door capacity
9. Card Readers:
   a. SmartCard
   b. Proximity.
   c. Magnetic Stripe.
   d. Wiegand.
   e. Barcode.

2.14 CONTACTLESS SMART CARDS

A. Multiple Technology Access Card:
   1. The card shall support 13.56 MHz iClass contactless smart chip and antenna plus any or all of the following technologies, simultaneously:
      a. 125 kHz HID Proximity chip and antenna.
      b. Magnetic Stripe.
      c. Embedded Contact Smart Chip Module.
   2. The card shall be available with a 13.56 MHz iClass contactless smart chip and antenna plus a Wiegand Strip with an optional magnetic stripe, meeting all ISO 7810 standards except for card thickness, which shall be 0.037 inch (0.939 mm). The card will not be available with 125 kHz proximity technology and/or an embedded contact smart chip module.
   3. Manufacturer: HID iClass

2.15 BLUE LIGHT STROBE

A. Blue Light Strobe:
   1. Contractor shall field verify and coordinate all mounting locations with Architect, Architectural plans, and elevations.
   2. Blue light strobes shall provide visual signal during “Lockdown” operation. See Part 2.16-A.3.a for Lockdown Order of Operations.
   3. Strobe shall be an LED strobe providing efficient light for visibility in direct sunlight, providing a minimum of 270 lumens (92 Candela).
   4. Strobe shall be indoor/outdoor rated.
   5. Operating temperature shall be -40 degrees F to +158 degrees F.
   6. Flash Rate shall be up to 375 per minute.
   7. Strobe shall be UL 2017 compliant as part of enclosure, IP56 rated, and NEMA 4 rated.
   8. Provide and install all necessary accessories, backboxes, and mounting brackets for the installation.
   9. Strobe shall fully integrate with the access control system.
   10. Manufacturer: Code Blue S-1000 LED Beacon/Strobe

2.16 EMERGENCY BUTTON

A. Emergency Button:
   1. Contractor shall field verify and coordinate all mounting locations with Architect, Architectural plans, and elevations.
   2. Emergency button shall be a round button with a clear cover and shall say “Emergency Use Only” over the button.

3. Emergency buttons shall be use to activate “Lockdown” operations within the building.
    a. Lockdown Order of Operations:
        1) Individual inside building presses an emergency button to lockdown current room
        2) Access control system lockdowns current and all rooms while notification goes to dispatch building which is to be determined. Response is dispatched as needed.
        3) Blue light strobe outside building flashed as a warning signal.
        4) Rooms when in lockdown mode are assessed one by one. They can be entered by presenting an authorized badge at the card reader.
    b. Verify all operational requirements with owner prior to installation and programming.
    c. Contractor to program all associated groups and access levels for access control system, including the override badge for the card readers, for rooms to be accessed during lockdown mode.
4. Emergency button cover shall be supervised and issue access control system alarm when it is opened, with a second alarm when it is pressed.
5. Emergency button shall give audible alarm when cover is opened.
6. Manufacturer: HID Safety Technology International SS23A4ZA-EN with custom label: “Emergency Use Only”

PART 3 EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. The system shall only be provided by Contractors who are factory authorized to install, service and maintain the system by the access control manufacturer.

B. The Contractor must have been a factory authorized dealer with the proposed manufacturer for a period of at least two (2) years before the Bid Opening Date.

C. The Contractor’s installers and technicians must also be factory trained and certified to perform such tasks.

3.2 EXAMINATION

A. The Contractor shall be required to visit the installation site prior to bidding the job.

B. The Contractor shall report any discrepancies between the Specifications, Drawings, and Site Examination prior to the Bid Opening Date.

3.3 PREPARATION

A. The Contractor shall order all required parts and equipment upon notification of award of the Work.

B. The Contractor shall bench test all equipment prior to delivery to the job site.

C. The Contractor shall verify the availability of power where required. If a new source of power is required, a licensed electrician shall be used to install it.

D. The Contractor shall arrange for obtaining all programming information including access times, free access times, door groups, operator levels, etc.

3.4 INSTALLATION

A. The Contractor shall coordinate with the SAC’s IT Department if connecting to their network.

B. The Contractor shall carefully follow the instructions in the manufacturers’ Installation Manual to insure all steps have been taken to provide a reliable, easy to operate system.

C. The Administrator Terminal shall be connected to the remote terminals before connecting to any card reader processors.

D. The Contractor shall coordinate with the SAC’s locksmith if converting from mechanical to electric locks.

E. Perform all Work as indicated in the Drawings and Specifications.

F. The Contractor shall install the appropriate cable from the CPU to readers, door contacts, request-to-exit devices, and electric locks at each door and/or gate.

G. All communications cables shall be kept away from power circuits.

H. The Contractor shall install the power supply(s) for electric locks in locations where they won't interfere with other operations.

I. The Contractor shall also execute adequate testing of the system to insure proper operation.

J. The Contractor shall provide adequate training of the system users to insure adequate understanding to prevent operating errors.

3.5 WORKMANSHIP

A. Comply with highest industry standards, except when specified requirements indicate more rigid standards or more precise workmanship.

B. Perform Work with persons experienced and qualified to produce workmanship specified.

C. Maintain quality control over suppliers and Subcontractors.

D. Quality of workmanship is considered important. SAC Project Manager will have the authority to reject Work which does not conform to the Drawings and Specifications.

3.6 EQUIPMENT PRE-TEST

A. All equipment shall be bench tested prior to delivery to job site and prior to installation. Bench test per manufacturer's installation instructions.

3.7 WIRE AND CABLE

A. Design, layout, size, and plan new wire and cable runs as required.

B. All wire and cable from the processors to all devices at each door shall be "home-run" unless otherwise specified.

C. All wire and cable, including any wire and cable that is existing and will be reused in the Work, shall be installed in conduit or surface metal raceway, except as follows:

D. Wire or cable, in lengths of less than ten (10) feet, that is "fished" within walls, ceilings, and door frames.

E. All wire and cable passing thru metalwork shall be sleeved by an approved grommet or bushing.

F. Avoid splicing conductors. All splices shall be made in junction boxes (except at equipment). Splices shall be made with an approved crimp connection. Wire nuts shall not be used on any low-voltage wiring.

G. Identify all wire and cable at terminations and at every junction box. Identification shall be made with an approved permanent label, Brady or equal.

3.8 WIRE AND CABLE TERMINATIONS

A. Identify all inputs and outputs on terminal strips with permanent marking labels.

B. Neatly dress and tie all wiring. The length of conductors within enclosures shall be sufficient to neatly train the conductor to the terminal point with no excess. Run all wire and cable parallel or normal to walls, floors and ground.

C. Install connectors as required by equipment manufacturers.

D. Terminations shall be made so that there is no bare conductor at the terminal. The conductor insulation shall bear against the terminal or connector shoulder.

E. Do not obstruct equipment controls or indicators with wire or cable. Route wire and cable away from heat producing components such as resistors, regulators, and the like.

3.9 CONDUIT AND RACEWAY INSTALLATION

A. Design, lay-out, size and plan new conduit and raceway systems as required.

B. Indoor Requirements:

1. Route exposed conduit and raceway parallel and perpendicular to walls and adjacent piping.
2. Maintain minimum six (6) inch clearance between conduit and piping.
3. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps.
4. Use conduit bodies to make sharp changes in direction, as around beams. Fasten conduits and raceways to structural steel using approved spring clips or clamps.
5. Where conduit penetrates fire-rated walls and floors, seal opening with UL listed fire rated sealer or other methods as approved by codes.
6. No exposed conduit, raceway, or junction box shall be installed within any office area.
7. Install all boxes straight and plumb.
8. Do not support conduit from mechanical, plumbing, or fire sprinkler systems.
9. Drill or core drill all holes in walls, ceilings, or floors where required for new conduits. Do not cause damage to any structural steel or other structural support member by drilling or cutting.
10. Do not use flexible conduit in lengths longer than six (6) feet.

C. Outdoor Requirements:

1. Where conduit penetrates exterior walls, seal opening around conduit in an approved manner to make watertight.
2. Use galvanized straps and fasteners on all exterior conduit.
3. All exterior boxes will only be used to aid in pulling the cable between points.

3.10 PENETRATIONS

A. Do not penetrate any roof, flashing, exterior wall, or parapet without prior approval from **SAC**'s designated Construction Project representative.

B. When penetrating a fire wall for passage of cables and/or conduit, always provide a fire-stop system that complies with code and the local authority having jurisdiction.

3.11 FIRE RATED DOORS AND FRAMES

A. Do nothing to modify a UL. rated door or frame that would void the UL. Label or fire rating.

3.12 GROUNDING

A. Provide earth-grounding of equipment as required by equipment manufacturer. Earth ground shall be connected to ground rod or approved cold water pipe. Electrical or telephone ground connections shall not be used as earth grounds. Connections to mounting posts or building structural steel shall not be used as earth grounds.

3.13 POWER TO SECURITY EQUIPMENT

A. Power all equipment from 120 VAC circuit dedicated for security use, except as noted. Mark all panel circuit breakers with labels worded "Security Equipment - Do Not Operate", or equivalent.

B. All plug-in transformers shall be located at the security control panels. Secure all low-voltage plug-in transformers to outlet with screw or strap. Clearly label all transformers to identify purpose and use.

3.14 CUTTING AND PATCHING

A. The Contractor shall be responsible for all cutting, fitting or patching that may be required to complete the Work.

3.15 PAINTING

A. All surface raceway systems shall be painted to match the surfaces they are attached to. All surfaces damaged by the installation shall be repaired and painted by The Contractor.

3.16 PLYWOOD BACKING

A. Install the processor(s), power supplies, and all other related equipment on a plywood backboard for testing in the shop. The mounted assembly will then be transported “as is” to the job site for mounting in the Communication Room.

B. Fasten the plywood backing to the wall using a hanger bolt at the four corners which align with pre-drilled holes in the plywood. Secure with flat washers and a nut.

3.17 FIELD QUALITY CONTROL

A. Upon reaching Substantial Completion, perform a complete test and inspection of the system. If found to be installed and operating properly, notify SAC of your readiness to perform the formal Test & Inspection of the complete system.

B. Submit the Record Drawings (as-builts) to SAC for review prior to inspection.

C. During the formal Test & Inspection (Commissioning) of the system, have personnel available with tools and equipment to remove devices from their mounts to inspect wiring connections. Provide wiring diagrams and labeling charts to properly identify all wiring.

D. If corrections are needed, the Contractor will be provided with a Punch-List of all discrepancies. Perform the needed corrections in a timely fashion.

E. Notify SAC when ready to perform a re-inspection of the installation.

3.18 INITIAL PROGRAMMING AND CONFIGURATION

A. Contractor shall provide initial programming and configuration of the security management system. Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Security Consultant and Owner to determine operating parameters.

B. Contractor shall develop and input system graphics, such as maps and standby screens. Owner shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD .DWG or .DXF files, as the basis for the creation of maps.

C. Owner, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

D. Contractor shall maintain hard copy worksheets which fully document the system program and configuration. Worksheets shall be kept up to date on a daily basis by Contractor until final Acceptance by Owner. Worksheets shall be subject to inspection and approval by Owner. Provide final copies to Owner prior to Project Close-out.

E. Contractor shall maintain a complete, up-to-date magnetic tape backup of the system configuration and cardholder database. Backup shall be maintained throughout programming period until final Acceptance by Owner. Submit back-up tapes to Owner upon Final Acceptance.

F. Approximately sixty (60) days after start-up of system, Contractor shall return to project to provide follow-up assistance with system configuration as requested by Owner. Contractor shall include an allowance of forty (40) hours of labor for follow-up assistance in his Base Bid price.

3.19 TRAINING

A. Contractor shall provide complete operator training on the Security Management System. Training shall consist of thirty-two hours of classroom instruction for ten people selected by Owner, plus two (2) hours of individual hands-on training for each of ten people selected by Owner. Hands-on training shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.

B. Training shall cover all operating features of the system, including the following:

1. System set-up and cardholder database configuration.

2. Access control features.
3. Alarm monitoring features.
4. Report generation and searches.
5. Card management and Badge Design/Printing
6. Disk backup procedures
7. Routine maintenance and adjustment procedures.

C. Training sessions are to be held at Owner's facility, and are to be scheduled at the convenience of Owner. Contractor shall provide written training outline and agenda for each training session prior to scheduling.

D. Weekly format of training sessions shall be as follows:
1. Monday: Afternoon Session: Control Center Training
2. Tuesday: All Day: System Administrator Training
3. Wednesday: All Day: System Administrator Training
4. Thursday: All Day: System Administrator Training
5. Friday: Morning Session: Control Center Training

E. Contractor shall provide written training materials for each of ten (10) people.

3.20 OPERATOR TRAINING

A. Contractor shall provide complete operator training on the Security Management System. Two types of operator training shall be provided:
1. System Administrator Training: Three-day comprehensive training course for system managers and maintenance personnel. Provide two (2) separate on-site training sessions.

B. Training sessions shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.

C. Contractor shall provide written training materials for each of ten (10) people at each training session.

D. Training sessions are to be held at Owner's facility, and are to be scheduled at the convenience of Owner. Some training sessions may be required to be held during evening hours and on weekends to accommodate users whose schedule does not permit attendance during regular hours.

E. Contractor shall provide written training outline and agenda for each training session prior to scheduling.

3.21 MANUFACTURER PROFESSIONAL SERVICES

A. Contractor shall coordinate with the manufacturer to provide the manufacturer's professional services team to assist the Owner in coordinating the interfaces between the security management system and other on-site systems as necessary.

B. Professional Services personnel shall be employed by the manufacturer of the security management system and shall be thoroughly knowledgeable of the security management system applications.

C. Professional Services personnel shall be on-site and available to meet with Owner's representatives for a period of not less than two consecutive days. On-site visit shall be scheduled at the convenience of the Owner.

END OF SECTION

SECTION 282300
VIDEO SURVEILLANCE

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Providing materials, equipment, submittals, fabrication, installation, labor, programming, configuration, and testing in conformity with applicable Codes and Authorities Having Jurisdiction for the following:

1. A complete Video Surveillance System as described in the Specifications and as shown in detail on the Drawings.
2. Complete Video Surveillance System is defined as all labor and materials required to complete the Work described herein and on the Drawings including but not limited to: conduit, raceways, cables, cabling, wiring, connectors, riser blocks, patch panels, patch cables, network interfaces, back boxes, IP Network Cameras using PoE, analog cameras using digital video encoders, camera lenses, KVM's (video monitors, keyboards, mice), Network Video Recorders, attached data storage hard drive arrays (SAN/NAS), PoE switches, programming, power supplies, power distribution units (PDU's, plug strips), enclosures, tamper switches, latches and locks, mounts, arms, housings, stands, relay interfaces and equipment rack cabinets or rack shelves.
3. Products, equipment, materials, systems, assemblies, software and accessories as specified herein define the minimum standards. Specifications and Drawings do not show or list every item, accessory, fastener, bracket, sub-assembly and appurtenance to be provided. When an item not shown or listed is clearly necessary for proper installation, operation and functioning of the equipment and systems the Security Contractor shall provide, install, test and certify the item at no increase in Contract price.
4. Provide all software, licensing, hardware, cabling, and programming required for the installation, connection, programming, customization, and functional operation of the new Video Surveillance System equipment.
5. Provide and install system video cameras, camera licenses, and labor to the existing ONSSI Video Surveillance System.
6. Provide installation, testing, adjustment and initial configuration programming for all equipment and systems.
7. Provide configuration programming to import floorplan graphical maps of the project sites and to populate the maps with functional device icons in the Video Surveillance System.
8. Coordinate data network connections, programming, and power requirements with Owner's IT department.
9. Conduit, wire, and cable installations performed under this Section shall comply with all applicable Local Building Codes and National Electrical Code with California Amendments.
10. Security Contractor is responsible for fully implementing the Work described in the Specifications and shown on the Drawings to create a fully functional and completely operational Video Surveillance System.

1.2 RELATED SECTIONS

A. 280500 Common Work Results for Electronic Safety and Security Systems

B. 280800 Commissioning of Electronic Safety and Security Systems

1.3 REFERENCES

A. Published specifications, standards, tests and codes and recommended standards of trade, industry or governmental organizations apply to Work in this Section including:

1. ADA – Title 3 of the Americans with Disabilities Act
2. ASCII – American Standard Code for Information Interchange
3. ASTM – American Society for Testing and Materials
4. CCR – Titles 19 and 24 of the California Code of Regulations
5. EIA – Electronic Industry Association
6. NEMA – National Electrical Manufacturers' Association
7. NFPA – 2010 National Fire Protection Association Standards

8. CEC – 2008 National Electrical Code with 2010 CA Amendments
9. CBC – 2009 International Building Code with 2010 CA Amendments
10. CFC – 2009 International Fire Code with 2010 CA Amendments
11. CMC – 2009 International Mechanical Code with 2010 CA Amendments
12. UL – Underwriters Laboratories, Inc.

B. Electronic devices radiating "RF" energy shall comply with Federal Communication Commission regulations, particularly Part Fifteen, and shall meet Class "B" requirements. Provide FCC certificate numbers indicating that the FCC has approved the products.

1.4 QUALITY ASSURANCE

A. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.

B. All items of a given type shall be the products of the same manufacturer.

C. All items shall be of the latest technology; no discontinued models or products are acceptable.

D. No “beta” products will be accepted.

E. Security Contractor shall:
   1. Stock a full complement of parts of the same manufacturer and model as installed per these Specifications.
   2. Offer service during normal working hours as well as emergency service on all equipment installed per these Specifications.
   3. Supply parts and service without delay and at reasonable cost.

F. Security Contractor shall be certified for asbestos work (if applicable to this Project).

G. Security Contractor shall be capable of performing service and maintenance on the specified systems.

H. Security Contractor’s lead technician shall be trained and certified by the Video Surveillance System manufacturer and the wireless camera manufacturer. Certifications shall also be held for all aspects of the installation and testing as noted in sections 3.02 A, 3.05 A, and 3.08 C of this specification.

I. Security Contractor shall possess all required Contractor's licenses.

J. The contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.

K. The contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.

L. Contractor shall have a minimum of five (5) years of recent experience on structured cabling systems of similar type and size.

M. Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.

N. The contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

O. The contractor shall own and maintain the tools and equipment approved by the cabling system manufacturer for successful installation and testing of Category 6 balanced twisted pair distribution systems.

P. The contractor shall have personnel who are adequately trained in the usage of such tools and equipment.

1.5 SUBMITTALS

A. Contractor shall provide the following submittals:
   1. Project Schedule

2. Product Data and Shop Drawings
3. System Programming
4. Operation & Maintenance (O&M) Manual
5. “As-Built” Record Drawings
6. Contractor shall submit a resume of qualification with the Contractor's proposal indicating the following:
    a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each
    b. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.

B. Unless otherwise noted or required by the Owner, all submittals shall be supplied in Adobe Acrobat “.pdf” format and/or in native Microsoft Office Word “.doc” or Excel “.xls” format.
    1. All delivery of required project submittals shall be accompanied by dated transmittal listing the contents.

C. Submittals must be complete. All security system submittals shall be in a similar format for ease of review. The Owner and Security Consultant reserve the right to reject any submittals determined to be incomplete. Rejection of submittals for failure to meet these requirements shall not be considered grounds for claims of delay.

D. Submit the following Project Schedule submittal to the Owner and Security Consultant for review and approval prior to commencement of Work:
    1. Proposed construction schedule detailing the timeline for the Project. Obtain Owner approval of finalized construction schedule before the commencement of Work.
    2. Confirm sequence of site work and illustrate how multiple concurrent site projects will overlap. Provide and detail float as contingency. Include Owner activities in the schedule.
    3. When Work is performed in a sensitive area or in areas occupied with ongoing activities, coordinate with the Owner and the affected site’s representative to determine the best time to perform the Work required. Sequencing and scheduling of this type is normal on a Project of this nature and shall not be considered grounds for claims of delay.

E. Submit the following Product Data and Shop Drawings submittals to the Owner and Security Consultant for review and approval prior to commencement of Work:
    1. Manufacturer's name, brand name, exact part number, options, accessories and catalog references for all equipment supplied including cabling. Indicate UL Listings for all system components.
    2. Complete wiring diagrams for all components, including cable types and quantities, routings, floor plans indicating device locations, conduit sizes, point-to-point termination and riser diagrams.
    3. Master Device Legend Table on the shop drawings that identifies the symbols used for all devices including mounting heights, back box requirements, part and model numbers, operating voltages (if applicable), wire and cabling requirements, wire label verbiage, and panel termination points.
    4. Fully dimensioned shop drawings including plan views, elevations and details of all security device installations, equipment rooms and closets, consoles, controllers, racks, enclosures, control panels, and fabricated equipment, showing locations of all major components including mounting details. These Drawings shall be 1/4 inch scale at a minimum.
    5. Bill of Materials.
    6. MSDS for fire stopping materials and sealants.
    7. Written certification letter from each manufacturer affirming that Security Contractor is approved for systems installation and service for all systems in this Section.
    8. Partial or “Typical” Drawings will not be accepted. All shop drawings shall be done in AutoCAD.

F. Submit the following System Programming submittals to the Owner and Security Consultant for review and approval prior to commencement of Work:
    1. Submit for review and approval proposed programming, including device names and text descriptions, frame rates, resolutions, IP addresses, and sequence of operations at least 30 days prior to the actual programming of the system.
    2. Approved device naming conventions shall be reflected on the “As-Built” Record Drawings and on device and cable labeling exactly as programmed into the system.

G. Submit the following Operation & Maintenance (O&M) Manual submittals to the Owner and Security Consultant for review and approval upon completion of Work:
   1. Updated product data and shop drawings submittals reflecting the actual accurate "As-Built" conditions.
   2. Warranty letter with start and end date. Clearly note the date of written notification of acceptance by the Owner.
   3. Troubleshooting checklist information.
   4. Replacement parts and consumables ordering information, including the contact information for local sources.
   5. Warranty service and maintenance contact information: including names, address, phone number and website address. Provide specific instructions or forms as required to initiate a trouble ticket or work order request.
   6. Training program, including name and qualifications of trainer(s), schedule of training, and curriculum. O&M's shall be provided as the written training materials and shall be turned over to the attendees upon completion of training.

H. Submit the following "As-Built" Record Drawings submittals to the Owner and Security Consultant upon completion of Work:
   1. Maintain a complete set of "As-Built" Record Drawings updated with mark-ups inserted as the Work is performed. As Work is installed carefully mark on "As-Built" Record Drawings in colored pencil the correct location of all Work including depth of underground runs and concealed Work with their dimensions from clearly identified points on permanent buildings, fixtures, walls, or walks. Wiring diagrams, risers and details shall be included and updated.
   2. Upon completion of the Project transfer hand-drawn information to CAD Drawings. Copy updated CAD Drawings onto compact disc in ".dwg" and Adobe Acrobat ".pdf" formats and submit to the Owner and Security Consultant. No hand-drawn "As-Built" Record Drawings will be accepted.
   3. "As-Built" Record Drawings shall be provided in three (3) full-size hardcopy plotted sets as well as on compact disc to the Owner. One (1) additional complete full-size hardcopy plotted set shall remain on the Project site at the primary security equipment location at the District Office.

1.6 SUBSTITUTIONS

A. All equipment, products and systems shall conform to the Specifications and Drawings. No substitute equipment, products or systems may be used unless previously accepted in writing by the Owner and Security Consultant.

B. Substitution requests must be submitted in writing for review and approval by the Owner and Security Consultant. Requests must clearly show a line by line comparison of the relevant product technical specifications to demonstrate that the proposed substitution meets or exceeds the technical specifications of the specified product. The Owner and Security Consultant reserve the right to accept or reject substitution requests.

C. Manufacturers listed as acceptable are normally engaged in the type of Work specified. The listing of equipment and product part numbers or particular types of systems by specific manufacturers is to establish a minimum standard for the performance, quality, and parameters of the equipment, products and systems specified. The Owner and Security Consultant must approve all substitutions in writing prior to any substitute equipment, products or systems being incorporated into this Project.

D. Any substitute equipment, products or systems incorporated into this Project without prior written approval from the Owner and Security Consultant will be considered defective and may be rejected at the discretion of the Owner. Rejected items shall be promptly removed from the Project and replaced with the specified materials and equipment by the Security Contractor at no increase in Contract price and shall not be considered grounds for claims of delay.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Ship equipment in original manufacturer packaging to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturer recommendations. Provide protective covering of installed items during construction. All equipment is to be protected from dents, bumps, and scratching.

B. Replace, at no increase in Contract price, all equipment, products, or systems damaged during shipping, handling, distribution, storage, or installation or during subsequent construction.

C. Products delivered to the Project site and stored, whether on the Project site or in an off-site location previously approved in writing by the Owner, shall be protected from weather, dust, dirt, and foreign matter. Storage shall be locked and secured at all times when not under direct supervision and use.

1.8 PROJECT WARRANTY

A. Security Contractor and system and product manufacturers guarantee installation, equipment, computer hardware, software, software support, licenses, and all parts and labor for five (5) years from date of written notification of acceptance by the Owner, as the base bid. Additional Alternates are described in the Add Alt specifications. Contractor shall price all Add Alts as separate line items for consideration.

1. Contractor shall have cameras readily available for proper swap outs during the 5 years of warranty, if needed.

B. Project warranty is in addition to and supplements any existing or future Service Level Agreement (SLA) and shall not be construed to diminish existing or future agreements in any way.

C. Security Contractor shall provide, upon notification of a problem, a field service technician to correct the problem within twenty-four hours of notification or as otherwise agreed to in an existing or future Service Level Agreement (SLA).

D. At sixty days prior to expiration of warranty Security Contractor shall perform complete system functionality testing as described in PART 3 TESTS AND REPORTS of this Section.

1. Warranty shall not expire and shall remain in full force and effect until all identified problems and deficiencies are corrected and system is fully functional and completely operational.

PART 2 – PRODUCTS

2.1 NETWORK CAMERAS

A. Network Cameras will transmit images over the Local Area Network (LAN). Contractor to provide an excel sheet, listing cameras and their locations to the Owner to provide the IP addresses/host names as part of the base bid.

B. All network cameras will be IP-based cameras. No analog cameras will be used/approved/accepted for the purpose of this scope of work.

C. All network cameras will terminate in their designated IDF rooms or closets. The location of these rooms/closets shall be per the drawings and field verified. If discrepancies occur, contractor shall coordinate with IT.

D. All cameras shall be vandal resistant with vandal/tamper proof screws. Contractor shall provide (2) of each type of driver bit needed for the special vandal/tamper proof screws.

E. All cameras that require wide dynamic range (WDR), per specifications below, shall meet or exceed a range of 90 dB.

F. All shall be a minimum of IP66 rated water-resistant/dust-tight and IK10 rated vandal-resistant.

G. Integrated on-board analytics to trigger alarms based on user-defined rules for monitoring a doorway for access beyond approved hours.

H. All cameras shall have a minimum operating temperature range from -40° F to 122° F.

I. All cameras must have drivers compatible with ONSSI VMS Software, beyond onVif integration.

J. Interior Mini Dome Cameras:

1. Will be Day/Night with WDR per manufacturer specs.
2. Cameras will have built in support for Power over Ethernet.
3. Will be equipped with Varifocal lenses

4. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
5. Exmor CMOS sensor with integrated image stabilizer to minimize vibration effects on image.
6. Built in IR illuminators. Minimum illumination of 0 lx in B/W and 0.1 lx in Color.
7. These will be flush, surface, wall and corner mounted as indicated in the device schedule and via field verifications at the responsibility of the contractor.
8. These cameras will be located in the following areas:
    a. Classrooms/ Office areas
    b. Interior classroom corridors
    c. Perimeter areas.
9. Part number:
    a. Sony SNC-EM632R
    b. Or approved equivalent

K. Exterior Mini Dome Cameras:

1. Will be Day/Night with WDR per manufacturer specs.
2. Cameras will have built in support for Power over Ethernet.
3. Will be equipped with Varifocal lenses
4. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
5. Exmor CMOS sensor with integrated image stabilizer to minimize vibration effects on image.
6. Built in IR illuminators. Minimum illumination of 0 lx in B/W and 0.1 lx in Color.
7. These will be flush, surface, wall and corner mounted as indicated in the device schedule and via field verifications at the responsibility of the contractor.
8. These cameras will be located in the following areas:
    a. Throughout exterior corridors.
    b. In critical areas.
    c. Exterior of building and campus entrances.
    d. Other areas as designated.
9. Part number:
    a. Sony SNC-EM632R
    b. Or approved equivalent

L. Exterior Fixed Megapixel Camera

1. Will be Day/Night with WDR per manufacturer specs.
2. Each camera assembly is 3 to 5 MP, clear dome, auto-focus/remote-focus, auto iris, with lowlight capability.
3. Cameras will have built in support for Power over Ethernet.
4. Will be equipped with Varifocal lenses
5. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
6. Outdoor (IP66) rated.
7. These will be flush, surface, pole, wall and corner mounted as indicated in the device schedule.
8. Built in IR illuminators.
9. These cameras will be located in the areas designated on the floor plans.
10. Approved Manufacturers:
    a. Sony SNC-CH280
    b. Or approved equivalent

M. Interior Fixed Dome Megapixel Camera

1. Will be Day/Night with WDR per manufacturer specs.
2. Each camera assembly is 3 to 5 MP, clear dome, auto-focus/remote-focus, auto iris, with lowlight capability.
3. Cameras will have built in support for Power over Ethernet.
4. Will be equipped with Varifocal lenses
5. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
6. Outdoor (IP66) rated.
7. These will be flush, surface, pole, wall and corner mounted as indicated in the device schedule.
8. Built in IR illuminators.

9. These cameras will be located in the areas designated on the floor plans.
10. Approved Manufacturers:
    a. Sony SNC-CH280
    b. Or approved equivalent

N. Interior Fixed Bullet Megapixel Camera
1. Will be Day/Night with WDR per manufacturer specs.
2. Each camera assembly is 3 to 5 MP, clear dome, auto-focus/remote-focus, auto iris, with lowlight capability.
3. Cameras will have built in support for Power over Ethernet.
4. Will be equipped with Varifocal lenses
5. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
6. Outdoor (IP66) rated.
7. These will be flush, surface, pole, wall and corner mounted as indicated in the device schedule.
8. Built in IR illuminators.
9. These cameras will be located in the areas designated on the floor plans.
10. Approved Manufacturers:
    a. Sony SNC-CH280
    b. Or approved equivalent

O. Exterior PTZ Camera
1. Will be Day/Night with WDR per manufacturer specs.
2. Each camera assembly is 1080P/ 60FPS, clear dome, auto-focus/remote-focus, auto iris, with lowlight capability.
3. Cameras will have built in support for Power over Ethernet (HPoE).
4. 30X OPTICAL ZOOM, 700°/sec pan speed
5. H.264 compression or better shall be used. If deviating from H.264, written approval shall be obtained from SAC-IT.
6. Outdoor (IP66 & IK10) rated.
7. These will be flush, surface, pole, wall and corner mounted as indicated in the device schedule.
8. These cameras will be located in the areas designated on the floor plans.
9. Approved Manufacturers:
    a. Sony SNCWR632C
    b. Or approved equivalent

2.2 VIDEO SURVEILLANCE SYSTEM

A. Video Surveillance System Server Software and Computing Hardware

1. The existing Network Video Management software is from ONSSI, Ocularis Ultimate Edition.

2. All new cameras to being installed shall be programmed into the existing system.

3. Contractor shall provide additional channel licenses for the new cameras.

2.3 NETWORK VIDEO RECORDERS (NVR)

A. Owner will, configure, and install network-based video recorders compatible with the ONSSI Ocularis Ultimate Edition Software.

B. Owner will provide and install the following devices for the Science building IP Cameras:

1.	719061-B21	(1) HP DL380 Gen9 12LFF CTO Server
2.	719048-L21 3	(1) HP DL380 Gen9 E5-2650v3 FIO Kit
3.	719048-B21	(1) HP DL380 Gen9 E5-2650v3 Kit
4.	726718-B21	(4) HP 8GB 1Rx4 PC4-2133P-R Kit
5.	724864-B21	(1) HP DL380 Gen9 2SFF Bay Kit
6.	793703-B21	(12) HP 8TB 12G SAS 7.2K 3.5in 512e SC HDD
7.	764925-B21	(2) HP 240GB 6G SATA VE 2.5in SC EV M1 SSD
8.	761874-B21	(1) HP Smart Array P840/4G FIO Controller

9. 783007-B21 (1) HP DL380 Gen9 P840/440 SAS Cable Kit
10. 785991-B21 (1) HP DL380 Gen9 12LFF SAS Cable Kit
11. 726903-B21 (1) HP Smart Array P841/4GB FBWC 12Gb 4-ports Ext SAS Controller
12. 733662-B21 (1) HP 2U LFF Easy Install Rail Kit
13. 720478-B21 (1) HP 500W FS Plat Ht Plg Pwr Supply Kit
14. BD505A (1) HP iLO Adv incl 3yr Tech Support and Updates 1-Svr Lic
15. H7J33A5 (1) HP 5yr Foundation Care NBD w DMR Service
16. H7J33A5:R2M (1) iLO Advanced Non Blade - 3yr SW Supp
17. H7J33A5:TT3 (1) HP ProLiant DL380 Gen9 HW Supp

2.4 PATCH PANELS AND JUMPER CABLING

A. Patch Panels will be provided by the contractor where necessary.

B. Contractor to provide the Category 6A patch cords to be connected from the patch panel to the Network Switch. Network switch will be provided by SAC.

2.5 WIRE AND CABLE

A. Wire and Cable Specifications

1. Security Contractor shall follow the manufacturers' recommendation for cabling or the minimum requirements of the Specifications and Drawings, whichever provides for the most stringent requirements.
2. Wire and cable sizes, number of conductors, shielding, or other data listed in this Specification or shown on Drawings are a guide to the correct product required to achieve a working system and represent the minimum acceptable equipment.
3. Cables are to be shielded as necessary to preclude any outside noise or interference from entering the cable and degrading system performance. All cables shall be U.L. Listed, and appropriate for the application.
4. Use proper grounding practices to eliminate shorts, ground faults, ground loops, RF interference, voltage fluctuations, foreign voltages and open circuits.
5. Coordinate with the Owner’s IT department for data network connections, terminations, dressing, routing, patch panels, and jumpers.
6. Cables run underground, under slab, or in slab shall be installed in conduit and environmentally rated for such application.
7. Cables above hard ceiling or inaccessible areas shall be installed in conduit. Stub up conduits from within walls into accessible spaces.
8. All cables run in environmental air handling spaces shall be plenum rated. Provide proper J-hooks or cable trays for cables not run in conduit.
9. Mixing of security low voltage cables with data network or telecomm cables or the cabling of other systems will not be permitted.
10. Security low voltage cables and Ethernet Category 6 cables shall be provided in colors as selected by the Owner.
11. Cables shall be routed along walls and at right angles. Cabling shall not be draped loosely or resting on pipes, HVAC ductwork and equipment, or suspended tile ceilings. Avoid routing cabling bundles across or within 18” of lighting fixture ballasts.
12. When installing cable do not pull or stretch cabling beyond the manufacturer’s maximum tensile strength.
13. Do not cinch tight cable bundles (especially Ethernet cables) with tie wraps. Bundle cables together using Velcro straps.
14. Cable shall be run in unbroken homerun lengths of 300 feet or less. No cable runs shall be over 300’will be accepted. Cable splices are not allowed.
15. Wiring shall be grouped and harnessed to facilitate access to all equipment, as well as maintenance and replacement of equipment.
16. Cabling shall be sized and installed according to California Electric Code requirements.
17. Cabling shall be West Penn, Belden, Connect-Air, or approved equal.

B. Communication/Network Cabling

1. All network cable used shall be purple in color.
2. Twisted-pair network cable shall meet or exceed Category 6A requirements in ANSI/TIA-568-C.2

3. Any fiber optic cable shall meet or exceed requirements in ANSI/TIA-568-C.3 as applicable per the approved type of fiber.
    a. If fiber cables are required due to distance limitations, this shall be identified, specified, priced, and submitted to SAC-IT for approval with your original bid documents.

C. Quality Assurance
1. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the owner or owner representative.
2. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
3. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
4. Material and work specified herein shall comply with the applicable requirements of:
    a. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications Cabling Standard, 2000-2004
    b. TIA – 569-B Commercial Building Standard for Telecommunications Pathways and Spaces, 2004
    c. ANSI/TIA/EIA – 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2002
    d. ANSI-J-STD – 607-A Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, 2002
    e. NFPA 70 – National Electric Code, 2005
    f. BICSI – Telecommunications Distribution Methods Manual, 10th Edition, 2003
    g. NEMA – VE-1 – Metal Cable Tray Systems, 2002
    h. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2001

PART 3 – EXECUTION

3.1 REQUIREMENTS

A. Video Surveillance System shall be fully functional and completely operational.

B. All wall, floor, and ceiling penetrations, regardless of the fire rating of the partition, must be properly sleeved with EZ-Path or conduit penetration assembly and properly sealed using approved fire stopping materials and sealants.
1. Exterior penetrations shall be properly sealed using approved weather-proof fire stopping materials and sealants.

C. Provide seismic restraint for all equipment, including equipment racks and consoles.

D. Security equipment, devices, brackets, mounting arms or pendants, junction boxes, cabinets, and enclosures shall be installed utilizing stainless steel tamper-resistant fasteners and mounting hardware.
1. Tamper-resistant fasteners shall be pin Torx.
2. Provide two (2) driver bits and hand tools to the Owner’s representative for each type and size of pin Torx security fastener provided.

3.2 CABLE

A. General (applicable to all cable types Cable shall be installed in strict compliance with the manufacturer's recommendations.

B. Maintain separation from other conductors (power, fire alarm, etc.) per NEC requirements and TIA/EIA standards.

C. The bending radius and pull strength requirements of all cable as detailed in the TIA/EIA standards and the manufacturer's installation recommendations shall be strictly observed during handling and installation.
   1. Pull cables simultaneously where more than one cable is being installed in the same raceway.
   2. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
   3. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cable or raceway.

D. Cable jackets shall not be twisted during installation. Cables showing evidence of twisting shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.

E. Cable shall be installed in a continuous (non-spliced) manner unless otherwise indicated.

F. Cable installed in conduit and/or ducts:
   1. Fill ratios shall not exceed NEC requirements.
   2. Cable shall not be pulled into conduit/ducts until the conduit/duct ends have been prepared for cable installation (i.e. reamed to eliminate sharp edges and insulated throat bushings installed). Cables pulled into conduit/ducts prior to conduit/duct end preparation shall be replaced at no additional cost to the Owner.
   3. Reinstate pull-wires in conduits and ducts after use to facilitate future addition of cables.
   4. Standard in-wall communication outlets shall be installed in a 4" x 4" x 2.4" device box with 1" conduit stubbed to above ceiling.

G. Cable installed in cable tray:
   1. Cable shall not be attached to the cable tray (i.e. cable shall be left "loose") with the exception of cable installed in cable tray (cable runway) within Telecom Rooms (see "Cable in Telecom Rooms" below).
   2. For performance reasons, station cable in tray shall not be combed.
   3. Cable shall be laid in tray in such a way as to present a neat and professional appearance

H. Cable NOT installed in conduit/ducts or cable tray:
   1. Cables shall be strapped or fastened for support. Staples and plastic cable ties are not acceptable.
      a. Straps and fasteners shall not be over-tightened. Cables showing evidence of over-tightening shall be replaced at no additional cost to the Owner, regardless of the outcome of cable testing.
      b. Straps, fasteners, and tie-wraps installed in plenum spaces shall be plenum rated.
      c. Reusable Velcro hook and loop style cable straps/fasteners shall be used within Telecom Rooms. The use of plastic tie wraps is not acceptable within Telecom Rooms (see "Cable in Telecom Rooms" below).
      d. Cables shall be bundled by application (horizontal or backbone) and by cable type (Cat 3, Cat 6 UTP, MM Fiber, SM Fiber, etc.). Cable applications and types shall not be intermixed within a bundle.
   2. Cables in suspended cable runs shall be supported at varying intervals. Cable spans shall be limited to 5 feet or less, and the length of spans shall vary along the cable path (i.e. a given span should not be exactly the same length as the span preceding or following it – "exact" spans can degrade cable performance).
   3. Cable installed on exposed surfaces or structural members shall be installed parallel and perpendicular to the surfaces. Surface contours shall be followed wherever possible. Cables shall be attached to surfaces at intervals not to exceed 3 feet.
   4. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. – with the exception of ceiling support anchors) is not acceptable.

I. Cable installed in Telecom Rooms
   1. Cable on backboards:
      a. Lay and dress all cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.

b. Cable shall be routed as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Secure all similarly routed and similar cables together and attach to D-rings vertically and/or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

J. Cable terminating on patch panels located on racks.
1. Route cables in Telecom Rooms to patch panels on racks by routing across cable runway to top of rack and then down vertical cable management sections to patch panel.

K. Cable Slack:
1. Provide cable slack (service loops)
2. Provide slack length as follows:
a. At the device box: Provide a minimum of 6 feet.

3.3 FIELD LABELING REQUIREMENTS

A. Labels shall be printed on self-adhesive labels.
1. Hand written labels or writing directly on equipment or cabling is not acceptable.

B. Label all networked equipment with the host name as shown on the drawings the drawings.
1. Security device addresses and text descriptions shall be reflected on the labeling and on the "As-Built" Record Drawings exactly as programmed into the systems in accordance with the approved System Programming submittal.
2. Cameras shall not be labled.

C. Cables shall be individually labeled at origin and termination at both ends as close as possible to their termination point, referenced to a master cable legend schedule as shown on "As-Built" Record Drawings.

D. Cabling homerun routing and Security Terminal Cabinets (STC) locations, if any, shall be noted on "As-Built" Record Drawings.

E. Cable labels shall be affixed to individual cables in the "flagged" position.
1. This means that the associated approved device address label is printed twice on a self-adhesive label with sufficient space between the duplicate text to wrap around the cable.
2. The printed label is then wrapped around the individual cable and affixed to itself.
3. This results in a "flagged" position label so that the complete device address label can be read from either side of the label.

3.4 TRAINING

A. Training shall be by engineers or technicians highly skilled in the systems installed and factory trained and certified by the manufacturer as qualified to train in the particular systems.

B. Training focus:
1. Main focus shall be on "help" features of the system. SAC-IT anticipates this will be the most used feature and users need to be trained to allow proper level of comfort and system familiarity.

C. Provide eight (8) hours of scheduled training for the equipment provided under this Section, including programming, operation, service, and maintenance.

D. Training shall be conducted at dates and times as directed by the Owner.
1. Provide proposed training schedule and syllabus for review and approval prior to beginning any training.
a. Coordinate with SAC-IT while composing proposed schedule.
2. Training will be provided over multiple sessions at multiple locations as needed to accommodate the dates and times and attendees as directed by the Owner.

3. The initial default distribution of training sessions shall be conducted as ten (10) 2-hour sessions subject to approval by the Owner.

E. Training sessions shall be shall be provided in a “train the trainer” model as well as in sessions for general users.

F. Documentation of completion of training shall be delivered to and verified by the Owner prior to release of retainage.

G. Provide hardcopy and softcopy training materials to turnover to all attendees for all training sessions. Training material handouts should include, at a minimum, Operation & Maintenance (O&M) Manual which includes the final Product Data and “As-Built” Record Drawings as described in PART 1 SUBMITTALS.

3.5 PROGRAMMING

A. All system programming shall be by the SAC-IT department.

3.6 CATEGORY 6A CABLE TESTING

A. Ethernet Category 6A Cabling shall be field tested after installation.

B. Documentation shall be submitted for review and approval by the Owner and Security Consultant to demonstrate that all cabling meets or exceeds ANSI/TIA/EIA 568-B.2-1 Commercial Building Telecommunications Cabling Standards and Transmission Performance Specifications for 4-Pair 100 Ohm Category 6 Cabling.

C. Deficiencies shall be corrected prior to utilizing the installed cabling as a component of the Video Surveillance System.

3.7 TESTS AND REPORTS

A. System testing and reporting will occur in two phases.

B. Security Contractor shall perform System Functionality Testing and correct all deficiencies prior to performing the Commissioning Testing with the involvement of the District Representative, SAC-IT, and Security Consultant.

C. Perform System Functionality Testing using manufacturer-certified personnel who have attended a manufacturer's training school for installation and testing of the systems. Perform testing with the test instruments and methodology as required by the manufacturer; testing by means other than the manufacturer's procedures will not be acceptable unless agreed to by the Owner and Security Consultant and manufacturer.

D. Security Contractor shall perform System Functionality Testing and document these tests for review and approval by the Owner and Security Consultant prior to the Commissioning Testing.

E. If testing will require monitors, mouse, and keyboards, contractor is to provide their own equipment at no extra cost to the client. Monitors, mouse, and keyboards are not provided by SAC-IT at any of the IDF rooms or IDF closet locations.

F. At a minimum, perform System Functionality Testing to demonstrate and document:
   1. Cameras
      a. The camera video feed displays on client workstations without flickering due to excessive latency greater than half of a second.
      b. The camera video feed displays on client workstations without pausing or freezing.
      c. The camera auto-focuses to display clear image acceptable by SAC-IT.
      d. The day/night interior and exterior cameras adjust properly between day and night lighting conditions.
      e. The Wide Dynamic Range and auto-backlight compensation cameras adjust properly to challenging lighting conditions to produce clear, bright, and focused images.
      f. The camera produces a stable picture with no roll, flutter or ghosting.
      g. The camera resumes operation and produces clear, bright, and focused images when PoE power or network connectivity is restored from a failure.

G. Upon completion of the System Functionality Testing Security Contractor shall submit written reports including but not limited to the following information:
   1. Certification that all devices and equipment meet or exceed the requirements of the System Functionality Testing.
   2. Certification that all equipment is properly installed, programmed, fully functional and completely operational, and conforms to Specifications and Drawings.
   3. Complete Bill of Materials of all equipment installed including quantity, make and model as well as serial numbers, MAC addresses, and IP addresses/host names of major components.
   4. Technician's field test reports of all cameras, cables, devices, and equipment.
   5. Test technician's name, company and date(s) of test.
   6. Exceptions shall be clearly noted in a Punch List.

H. Following review and acceptance of the System Functionality Testing report by the Owner and Security Consultant, the Security Contractor shall perform Commissioning Testing of all security system equipment and software in the presence of the Owner and Security Consultant.

I. Commissioning Testing shall include performance testing and functionality testing to demonstrate to the Owner that each system software and hardware component functions as required by the Specifications and Drawings. The Security Contractor shall be responsible for all additional costs to the Owner and Security Consultant if retesting is required.

J. At a minimum, perform Commissioning Testing in the presence of the Owner and Security Consultant to demonstrate and document:
   1. Each camera, cable, data network switch, NVR, server, and client computer workstation functions as an integrated element of the Video Surveillance System.
   2. Fully functional and completely operational condition of the cameras, client computer workstations, NVR's, and Video Surveillance System server.
   3. An abnormal condition of any signaling or communication circuit, device malfunction, or image loss required to be electrically supervised will result in activating the specified trouble or tamper alarm notification signal.
   4. All Video Surveillance System software functions properly in accordance with manufacturer's written specifications and all equipment is fully programmed.

END OF SECTION

SECTION 283100
DIGITAL ADDRESSABLE FIRE ALARM AND VOICE EVACUATION SYSTEM

PART 1 GENERAL

1.1 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 Specifications Sections and Drawings for related work required to be included as work under Division 26, 27, and 28.
2. General provisions and requirements for electrical work.

B. This Specification provides the minimum requirements for the Fire Alarm and Detection System. The system shall include, but not limited to all equipment, materials, labor, documentation and services necessary to furnish and install a complete, operational system to include but not limited to the following functions:

1. Smoke and fire detection.
2. Off-premise notification.
3. Mass Notification system.
4. One-way voice communication notification system.
5. Two-way voice communication system.

1.2 SUBMITTALS (ADDITIONAL REQUIREMENTS)

A. Submit eight copies of the following to the Architect for approval.

1. A listing of all fire alarm components and equipment including the California State Fire Marshal (CSFM) listing numbers.
2. CSFM listing sheets of all devices being used.
3. Manufacturers' standard catalog data for fire alarm components.
   a. The submittal shall be arranged in the order of the Specification and shall list the Specification paragraph number, the name, the proposed model and Manufacturer for each item as well as a reference indicating the specific piece of data which can be easily located in the brochure.
   b. The Manufacturers' data sheets shall be marked to indicate the specific item being proposed in cases where the sheet covers several types or sizes of item. The data sheet shall completely describe the proposed item.
   c. Where modification to the equipment is necessary to meet the operational requirements of the Contract Documents and the data sheets shall include complete Mechanical and Electrical Shop Drawings detailing the modification.
4. A listing of the outlet rough-in needed for every device and equipment item. The applicable symbol which illustrates that rough-in item on the Job Plans shall be drawn on the proposal, opposite the description of the rough-in to facilitate locating the data by Field Personnel.
5. Elevation and dimensional information.

1.3 APPLICABLE STANDARDS

A. The Equipment shall be listed, labeled, and approved for the application shown in Contract Documents, as fire alarm equipment complying with the following requirements:

1. List of applicable Codes as of January 1, 2014:
   a. 2013 Building Standards Administrative Code, Part 1, Title 24 C.C.R.
   b. 2013 California Building Code (CBC), Part 2, Title 24 C.C.R.
   c. 2013 California Electrical Code (CEC), Part 3, Title 24 C.C.R.
   d. 2013 California Mechanical Code (CMC), Part 4, Title 24 C.C.R.
   e. 2013 California Plumbing Code (CPC), Part 5, Title 24 C.C.R.
   f. 2013 California Fire Code (CFC), Part 9, Title 24, C.C.R.

g. 2013 California Referenced Standards Code, Part 12, Title 24, C.C.R.
h. Title 19, C.C.R., Public Safety, State Fire Marshal Regulations.
i. 2013 California Energy Code (CEC, Part 6, Title 24 C.C.R.

2. NFPA Standards and Guides:
   a. NFPA 13, Automatic Sprinkler Systems, 2013 Edition.
   b. NFPA 14, Standpipes Systems, 2013 Edition.
   c. NFPA 14, Dry Chemical Extinguishing Systems, 2013 Edition.
   d. NFPA 17A, Wet Chemical Systems, 2013 Edition.
   e. NFPA 24, Private Fire Mains, (included in 1999 NFPA 13) 2013 Edition.
   f. NFPA 72, National Fire Alarm Code, (California Amended) 2013 Edition.
   g. NFPA 253 Critical Radiant Flux of Floor Covering Systems, 2006 Edition.
   h. NFPA 2001, Clean Agent Fire Extinguishing Systems, 2012 Edition.
3. The fire alarm system shall conform to the applicable Standards and Guides referenced in CBC Chapter 60.

B. Written Certification by the Fire Alarm Equipment Manufacturer shall be submitted to the Architect, stating that the system and its component parts are listed and approved by the California State Fire Marshal and the installation has been tested, is operational and conforms to the requirements as set forth in Part 3, Article 24, Title 19, California Code of Regulations.

1.4 EQUIPMENT AND INSTALLING QUALIFICATIONS

A. The Equipment shall be manufactured by Notifier to match existing fire alarm equipment on the Campus.

B. The Specification is based on the Equipment of Manufacturers who has been approved by the District and the Manufacturers herein named shall be considered as meeting the requirements of this Specification. For all items which are identified by part number and Manufacturer the Performance Specifications which are published in the most recent Manufacturer's data sheets available at the time of bidding this Project shall be applicable to the present work as though fully written out herein.

C. All Equipment shall conform to all local applicable Codes and Ordinances, and shall be listed by Underwriters Laboratories.

D. To qualify as an acceptable Bidder, whether the bid is submitted to the District, his Agent, a General Contractor or a Sub-Contractor, the System Bidder or Contractor shall be Qualified Fire Alarm Contractor and shall hold a valid C10 License issued by the Contractors State License Board of California. The System Bidder or Contractor shall hereinafter be referred to as the Contractor. The Contractor shall hold all other licenses required by the legally constituted Authorities Having Jurisdiction over the work. The Contractor shall be the Factory Authorized Distributor for the branch of equipment offered and shall have been engaged in the business of supplying and installing the specified type of system for at least 5-years. The Contractor shall maintain a fully equipped service organization capable of furnishing adequate repair service to the equipment. The Contractor shall be financially able to provide a performance bond covering the work and the guarantee described. The Contractor shall provide that bond if requested.

E. Installation Certification
1. Work and material for cables, cable terminations and related components shall be performed by Certified Installers. The Installer shall be certified by the respective Product Manufacturers.
2. The Manufacturers of the indicated work and material shall provide an Installer Education/ Training and Certification Program for the supplied products.
3. The Installers performing the Contract Work for the indicated products shall have attended and successfully completed each of the respective Manufacturer's installation training education programs for the specified products.
4. Submit six copies of the Manufacturer's Certifications for each Installer performing the work. The submittal shall be approved prior to initiating any related Contract Work.
5. Contract Material Installed and work performed by Installers not complying with these requirements shall be removed. Removal of work and material not in compliance with these requirements shall done at the Contractors' expense, without any additional cost to the

Contract and without any additional Contract completion due date extensions. New material and work required to replace the non-compiling removed work and material shall be provided at the Contractors' expense, without any additional cost to the Contract and without any additional Contract completion due date extensions.

PART 2 PRODUCTS

2.1 GENERAL SYSTEM OPERATION

A. System shall be microprocessor-based, addressable, and power-limited with Class B supervised circuits, one-way and two-way emergency audio communications.
   1. The microprocessor shall execute all supervisory and control programming to detect, report the failure or disconnection of any system module or peripheral device and initiate programmed control sequences. An isolated supervision "watchdog" circuit shall monitor the microprocessor and, upon failure, shall activate the system trouble circuits.
   2. The automatic fire detection and alarm system shall consist of main control panel, transponder panel(s), notification alarm devices, remote annunciator, automatic detection devices, manual stations, printer, and CRT/keyboard, installed and wired in accordance with the Drawings and shall function as specified herein.
   3. The system shall be programmable in the field, by a non-computer trained person. All programmed information shall be stored in non-volatile memory.
   4. The system shall operate both addressable and non-addressable ionization, thermal and photoelectric detecting devices, manual stations, water-flow switches, and external control modules.
   5. The control panel shall provide power, annunciation, supervision and control for the fire detection and alarm system. The system shall be designed such that alarm indications override trouble and control conditions.
   6. External circuit supervision shall not require additional wires other than the pair used for detection or alarm (only two wires shall be used from the control panel to each loop of initiating devices and two wires for the notification alarm devices). These two wires shall provide both supervision and notification alarm signals. There shall be no loss of supervision for Class "B" wired addressable devices. Class "A" supervision may be provided by adding an additional pair of wires.

B. Alarm Conditions
   1. Actuation of any manual or automatic alarm initiating device, connected to the system shall cause the following automatic functions.
      a. All notification alarm signaling units shall activate continuously. Audible notification alarms shall sound the California State Coded Signal.
      b. The respective zone alarm lamp or annunciator alphanumeric readout on the central control panel, and remote annunciator panel, shall be activated.
      c. Activate the Digital Alarm Communicator system.
   2. Actuation of HVAC air duct smoke detectors shall stop the designated fans and motors in the building's air distribution system.
   3. Actuation of smoke detectors on either side of smoke doors shall energize the release mechanism on the smoke door causing the door to close.
   4. Notification alarm signal duration shall be capable of continuous sounding or adjustable from three to 10-minutes.
   5. Perform any additional functions as specified herein or shown on the Drawings.

C. Trouble Condition
   1. A single open or single trouble condition in a manual or automatic fire initiating wiring circuit shall activate the respective zone trouble lamp or annunciator readout on the fire alarm control panel and sound a trouble signal at the control panel.
   2. A single open or single trouble condition in the notification alarm signaling wiring circuit shall activate the trouble lamp or annunciator readout in the control panel and sound a trouble signal at the control panel.

3. 120 volt AC normal power shall be monitored with indication by a "power on" lamp. Upon normal power outage, the system shall activate power trouble condition lamp or annunciator readout, and indicate a trouble condition.
4. The control panel shall monitor the standby batteries and, upon a low battery condition, activate the low battery lamp or annunciator readout and indicate a trouble condition.
5. System ground detection shall be provided for the entire system. Upon ground detection, activate the ground detection lamp or annunciator readout and indicate a trouble condition.

D. Control Panels Employing Alphanumeric Readouts shall display the trouble condition along with a prompt to review the list chronologically. The end of the list shall be indicated.

2.2 FIRE ALARM CONTROL PANEL

A. General

1. The fire alarm control panel shall be software programmable, microprocessor controlled, solid state, electronic integrated system. The panel shall be the product of one Manufacturer. The control panel shall provide power, annunciation, supervision and control for the detection and alarm system. The detection system shall remain 100% operational, responding to an alarm condition while in the routine maintenance mode.
2. Addressable detection and control devices shall be individually identified by the system, and any quantity of addressable detection devices shall be in alarm and any quantity of addressable control units shall be operable at any time up to the total number connected to the system.
3. The microprocessor shall access the system program, which is stored in non-volatile programmable memory, for all Control-by-Event (CBE) functions. The system program shall not be lost upon failure of both primary and secondary power. Volatile memory shall not be acceptable.
4. A means shall be provided for acknowledging each abnormal condition. Each activation of the appropriate acknowledgement button shall sequentially acknowledge every point in the system. After all the points have been acknowledged, the LEDs shall glow steady and the panel audible signal will be silenced. The total number of alarms, supervisory, and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be so indicated.
5. An alphanumeric annunciator readout shall indicate on the control panel the activation by type, loop, and address of the specific device, sub-loop or alarm/ monitor/control point via an alphanumeric display. An audible alert shall sound at the control panel and an alarm light shall flash.
6. If the microprocessor fails, the system shall executive a default signaling program. This program shall enable the control panel to sound the audible signals and summon the Fire Department. In addition, a red LED shall light to indicate the communication loop wherein the alarm originated. Inability of the system to sound signals or summon the Fire Department during microprocessor failure shall not be acceptable.
7. Protected access to the system controls shall be provided to allow the user/ operator access to the following system functions:
    a. Status of all addressable points.
    b. Status of all events logged.
    c. Set/change the real-time clock and date.
    d. Perform an operational manual test of the system from the control panel, including actuation of any initiating device and trouble circuit without alarming the remote central station. The panel shall automatically return to normal mode in the event the panel remains unattended in the service mode.
    e. Retrieve from event log the last 300 alarms, or control points and 300 trouble conditions.
8. Individual input (monitor) and output (control) device addressability shall all be performed on the same pair of wires. Wiring shall be Class "A" or "B". When Class "B" wiring is used, no special wiring sequence shall be required on addressable device circuits. An unlimited number of wiring branches shall be permitted with no loss of supervision.
9. A minimum of 25% addressable monitor, trouble and control points shall be provided.

B. Cabinet

1. A metal tamper resistant cabinet shall contain the control panel components. Panel shall be surface or flush mounting as indicated on the Drawings. Provide a full height tamper resistant hinged locking cabinet door. The door shall have transparent, high impact windows to allow visual observation of all indicators and switches without opening the panel door.
2. "In-out" circuit conductors shall terminate on numbered screw-type terminals.
3. All groups of circuits or common equipment shall be clearly marked and shall be expandable by inserting interchangeable units.

C. The Control Panel shall provide positive protection against the fire alarm system inadvertently being left in a non-operating status. The alarm system shall automatically restore and resound alarms and trouble signals, if subsequent alarm initiating or trouble signals are received under any of the following conditions:

1. After the alarm or trouble silence switch have been activated.
2. Prior to resetting system after previous alarm or trouble conditions.

D. The System Indicating and Operational Control Devices shall be mounted on the control panel face behind the panel door and shall provide the following minimum functions:

1. Individual visual indicating pilot lights annunciator or alphanumeric readout to monitor the following alarm system conditions:
   a. Input power.
   b. System common alarm.
   c. System common trouble.
   d. Alarm or trouble signal silenced.
   e. Ground fault.
   f. Battery condition.
   g. Each individual alarm, control or initiating zone-activation.
   h. Each individual alarm, control or notification zone-trouble.
   i. Report, by specific device number, any device removed from an addressable initiating circuit, all other devices shall continue to function.
2. Manual control switches to allow the following system controls:
   a. Alarm silence.
   b. Trouble silence.
   c. Test all indicating pilot lights and readouts.
   d. System reset, including remote devices connected to the alarm panel.
   e. Alarm test to initiate an alarm condition from the control panel.
   f. Alarm disconnect for system testing without activating the Digital Alarm Communicator system.
   g. Changing the status of configured circuits (arming or disarming and changing status of relays). If any change in status degrades system operation as configured, a trouble condition shall be reported and remain until system operation again meets configured status.
   h. Perform multiple operations at the same time. These operations shall include but not be limited to timed functions and multiple configured sequences.

E. Alarm Initiating Zone Modules.

1. Shall supervise and accept remote alarm actuating device input signals. An alphanumeric readout shall indicate separate zone alarm and trouble indicators for each zone.
2. Zones shall be compatible, and designed to operate with the connected initiating devices either addressable or non-addressable type.
3. A spare double throw set of software programmable auxiliary alarm relay contacts shall be provided for control of remote devices for each zone. Contacts shall be rated 120-volt 60Hz 3 Ampere.
4. Each device on the system shall report as its own unique address.

F. Notification Alarm Signal Control.

1. Shall supervise and activate remote notification alarm devices.
2. Notification alarm shall be compatible and designed to properly operate with the connected audio and visual notification alarm devices, with no signal degradation.

3. The notification alarm shall provide group notification signal control of all notification zones.
4. The alarm modules shall be field resettable to provide either continuous or Coded Notification Alarm Signals. The Coded Alarm Signal shall provide an intermittent "on-off" pulsed sound activation of audible notification alarm devices.
5. A notification alarm circuit trouble indicating readout shall be provided for each notification zone.

G. Audio

The System shall be capable of delivering multi-channel audio messages simultaneously over copper and/or fiber media. All audio messages and live pages shall originate at the one-way audio control unit. The one-way audio control unit shall store pre-recorded audio messages digitally. These messages shall be automatically directed to various areas in a facility under program control. The system shall support remote cabinets with zoned amplifiers to receive, amplify and send messages through speakers over supervised circuits. The one-way emergency audio control shall provide control switches to direct paging messages as follows:
"All Call" to direct the page messages to all areas in the facility, overriding all other messages and tones.
"Page to Evacuation Area" to direct the message to the evacuation area(s), overriding all other messages and tones.
"Page to Alert Area" to direct page messages to the area(s) receiving the alert message and tones, overriding all other messages and tones.
"Page to Balance Building" to direct page messages to the areas) in the facility NOT receiving either the evacuation area or alert area messages.
"Page by Phone" switch to select the Fire Fighter's telephone system as the source for paging.
The System shall be capable of delivering multiple audio messages simultaneously over copper and/or fiber media. All audio messages and live pages shall originate at the one-way emergency audio control unit. The one-way emergency audio control unit shall store pre-recorded audio messages digitally. These messages shall automatically directed to various areas in a facility under program control. The system shall support remote panels with zoned amplifiers to receive, amplify, and distribute messages through speakers over supervised circuits.
The two-way voice communications control unit shall provide two-way communications between remotely located phones and the Command Center. The control unit shall provide the ability to individually select and display each two-way voice communication circuit support up to five remote telephones in simultaneous two-way voice communications.
Audio Amplifiers (Multi-Channel)
Provide one 20-watt audio amplifier per paging zone. There will be a total of two 20-watt amplifiers (one per floor). The system software shall be capable of selecting the required audio source signal for amplification. To enhance system survivability, each audio amplifier shall automatically provide a local 3-3-3 1000Hz temporal pattern output upon loss of the audio communications with the one-way audio control unit, during an alarm condition. Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall include a dedicated, selectable 25/70 Vrms output. Provide a standby audio amplifier that will automatically sense the failure of a primary amplifier, and replace the function of the failed amplifier.

H. Automatic Ground Detection shall detect either positive or negative voltages when earth connections of 50,000 OHMS or less occur, and activate the ground trouble signal.

1. A Ground Fault Code shall provide indication of either a positive or negative ground fault and shall operate the general trouble devices as specified herein but shall not cause an alarm to be sounded.
2. A short circuit error message shall be a Standard feature of the fire alarm control panel. Each communication loop shall be monitored for short circuits and shall have a distinctive error message for visual indication of circuits and operating trouble devices as specified herein but shall not cause an alarm to be sounded.

I. Power Supply

1. The dedicated power supply shall be adequately sized to properly operate the equipment, including remotely connected, spare and future indicated equipment with all alarm devices in

alarm condition. Provide 20% spare power supply capacity for future expansion. Provide transfer modules and multiple power supplies as required for proper operation.
2. Input voltage 120/240 volt or 120/208 volt 60Hz AC.
3. Surge transient voltage protection on the input and output phases of the power supply shall be provided.
4. Supervised voltage types (i.e., 120-volt 60Hz AC, 24 volt AC, 24 Volt D.C., etc.) required by special connected equipment shall be supplied, including but not limited to:
   a. Alarm initiating devices.
   b. Notification alarm devices.
   c. Control and annunciator panels.
   d. Fire and smoke dampers.
5. A solid-state power transfer circuit shall provide (UPS) Uninterrupted Power Supply between internal standby power and line power automatically and instantaneously if normal power fails or falls below 15% of normal ("brown out" conditions).
6. Individual circuit fuses shall be provided for smoke alarm detector power, main power supply notification circuits, battery standby power, and auxiliary output.
7. Provide lock-on device on each power supply dedicated branch circuit breaker at panel.

J. Battery Back-Up Operation
1. Internal batteries and battery power supplies shall be provided to allow 60-hours continuous automatic normal operation of the entire control panel and fire alarm system after the failure of the incoming utility power. Sufficient battery capacity shall remain at the end of 60-hour period to provide 10-minutes of continuous operation of all connected notification alarm devices.
2. Batteries shall be maintenance free, sealed, lead-acid or lead calcium or gelled electrolyte type rated 25% larger than required to provide power for the entire system upon loss of normal 120 VAC power for a period of 60-hours with 15-minutes of alarm signaling at the end of this 60-hour period.
3. The battery charger shall be automatic, dual rate with capacity to recharge completely discharged batteries in 18-hours. Charger shall be temperature compensated.

K. Lightning and Transient Voltage Surge Protection shall be a standard feature of the fire alarm control panel and shall be incorporated in the power supply circuit, common control circuits, signal circuits, and telephone line circuit.

L. Circuitry shall be provided in the control panel to permit transmission of trouble and alarm signals over leased or privately owned telephone cables to a remote receiving panel. A reverse polarity or a master box circuit as required shall be provided in the control panel. There shall be a supervised disconnect switch to allow testing of the fire alarm signal without transmitting an alarm signal to the central station.

M. The Alphanumeric Annunciator (printer and CRT/keyboard) shall list upon request:
1. Alarms with time, date and location.
2. Troubles with time, date and location.
3. Status of output functions, "on" or "off".
4. Sensitivity of addressable smoke detectors.
5. Detection device number, type and location.
6. Status of remote relays, "on" or "off".
7. Acknowledgment time and date.
8. Signal silence time and date.
9. Reset time and date.

N. The System shall also provide the following:
1. Counting the number of addressable detectors within a "zone".
2. Which are in alarm.
3. Counting "zones" which are in alarm.
4. Counting the number of addressable detectors which are in alarm.
5. Alarm on the system.
6. Differentiating among types of addressable detectors such as smoke detectors, manual stations, water-flow switches, thermal detectors.
7. Assigning priorities to types of detectors, zones or groups of detectors.

8. Cross-zoning.

O. Control Functions
   1. Control functions shall be assigned on the basis of multi-relational system initiation patterns of detection devices including full logic element equations using as "anding" zones, counting zones, counting devices, "anding" groups, conditional "if", "then", "or" programming and "anding" types of detection devices.
   2. Control functions shall be assigned on the basis of, cycle, delay, count, time of day, day of week, day of month and with a holiday schedule of up to 30-holidays per year. Each addressable detection device shall report its condition to the system control unit not less than every 4-seconds in a manner such that failure of the connections to the internal electronics of the device will result in a trouble signal which identifies the specific device involved.
   3. The system shall be field programmable for the response of control points to monitored devices.
   4. The operating software program shall provide programmable control for the Event-Initiated-Programs (E.I.P.) which shall allow automatic operation of system control points in the event of an alarm condition. To program this E.I.P.s, the system shall use a specifically designed user friendly programming language, which shall not require a knowledge of computer programming to learn and understand.
   5. The operating software shall support the following additional capabilities:
      a. Three levels of designated and unique Priority Alarms for each point.
      b. Designated "Sense Mode" for status interpretation for each point.
      c. Designated Print/No Print/Vectoring Mode for each point.
   6. The input statement defines the conditions required to activate the associated output statement. The input statement shall consist of single or multiple monitor point status, subroutine status, time comparison and the utilization of AND, OR, NOT, COUNT, and DELAY logic functions.
   7. The output statement defines the action to be taken by the control panel. The output statement shall consist of activation/deactivation of single or multiple control functions, subroutines, and remote Annunciator status LED's. Output statements shall also include the "Alert" messages.
   8. The software shall provide an "alert" message, unique to each point in the system, which will provide specific instructions for the operator on duty. These messages shall be up to five lines with up to seventy characters in each line. Each system monitor point shall have five specific alert messages when in alarm. Control points shall also be assigned alert messages.
   9. The hardware and software shall have the capacity to accept up to sixty-four independent programs. Each program shall have "Edit" or "No Edit" capability. Each program shall be written in an equation format comparable to ladder-logic equations. The Equations shall consist of an input and an output statement.
   10. Provide initial programming services for Coding, Loading and Debugging the initial District specified programs, as part of the Contract.
   11. Programming Command Definition
      a. Timing command shall provide time delay and time control functions based on internal clock/calendar by time of day; day of week; day of month; month in year.
      b. Count command shall provide a specific number of events to occur before a control action is initiated.
      c. Pulse command shall provide on control for a specific period of time.
      d. Cycle command shall provide on-off control for preset periods of time.
      e. Print command shall provide printing of specified information after an event occurs.

2.3 FIRE ALARM DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Enclosure shall be red.

B. Panel shall be solid state with eight zones for off premise monitoring of the fire alarm control panel.

C. System shall monitor alarm and trouble conditions. System shall be power limited.

D. System shall include dual telephone line switcher for central station reporting. Telephone lines shall be supervised.

E. System shall include dual battery harness, batteries, and battery charger.

F. System shall be UL listed for central station fire signaling systems (NFPA 71).

G. System shall be California State Fire Marshal approved for central station reporting.

H. System shall be Radionics D8112FA Series or Simplex 5071 Series. System shall be approved for connection to the fire alarm control panel.

I. Verify Specific Requirements with District and Central Station prior to submittals.

2.4 MANUALLY ACTIVATED ALARM INITIATING DEVICES

Manual Fire Alarm Boxes shall comply with CBC Sections 11B-309 and 11B-403.

A. An Electronic, Digital Multiplex, Addressable Module shall be incorporated into each device. The module shall communicate the status and trouble condition of each device with a unique Address Code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Devices shall be suitable for use on a Class "B", 2-wire supervised alarm initiating circuit.

C. Numbered Screw Type Terminals shall be provided for "in-out" connections of the alarm circuit wiring.

D. The Face of the Station shall have lettering indicating "FIRE" and operational instructions. Stations shall be tamper resistant, semi-flush mounting.

E. Auxiliary Spare Switch Contact shall be provided for control of remote devices rated 120 volts - 60Hz, AC - 3AMP minimum.

F. Stations shall provide visual indication the station has been activated. A key (and/or special tool) shall be required to gain access into the station to reset the station after being activated.

G. Stations shall be "Nonbreak-Glass" type.

H. RF and Transient Filtering shall be provided in the device electronics.

I. Pull Stations shall be Non-Coded double action, requiring a two District manual "pulling" actions to initiate the fire alarm system.

J. Stations Installed Outdoors shall be weather resistant construction, double action to activate the pull station.

2.5 AUTOMATIC ALARM INITIATING DEVICES

A. General

1. An electronic digital, multiplex, addressable module shall be incorporated into each device. The module shall communicate the status and trouble condition of each device with a unique Address Code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.
2. Devices shall be suitable for use on a Class "B", 2-wire supervised alarm initiating circuit. Where initiating devices are shown connected to an existing system, devices shall operate on 2 or 4-wire circuits plus, 2-wire power circuit as required by the existing equipment.
3. Numbered screw type terminals shall be provided for "in-out" connectors of the alarm circuit wiring.
4. Auxiliary double throw spare relay contact shall be provided for activation of remote rated devices 120-volt 60Hz, AC, 1 Ampere minimum.
5. RF and transient filtering shall be provided in the initiating device electronics.
6. Initiating devices shall be reset from the control panel and shall not require individual resetting.

B. Smoke Detector

1. Detectors shall comply with UL standard 268, 167 and 168, and shall use solid state electronic circuits throughout.
2. The smoke detector shall operate on a total of two circuit wires. Alarm signaling and detector power shall use the same conductors. Detector sensitivity shall be factory set at 1.5%. Provide testing provisions in accordance with CFC 907.9.3 – 907.9.4.1, NFPA72.
3. A fine mesh insect screen shall be provided on all detector openings.
4. The detector shall lock-in on alarm and shall provide a visual alarm/trouble indicator light. An electromechanical test feature shall provide functional testing of the unit without smoke.
5. The detector shall also incorporate a fixed temperature heat detector rated at 135 degrees F. The heat detector shall operate the alarm circuit and alarm/trouble light.
    a. Photo electric type smoke detectors shall employ a Light Emitting Diode (LED) as the detector light source, activated by the presence of combustion smoke products. Failure of the LED shall activate the alarm/trouble light on the detector.
    b. Ionization type smoke detector shall employ the triple chamber (dual chamber) ionization principle, activated by the presence of combustion products. The ionization chamber shall be RF shielded.
    c. Air duct smoke detector photo electric or ionization type for installation on a mechanical air ducts. Two air tubes shall extend into the air duct. The sampling tube shall extend across the entire width of the air duct. The second tube shall allow air to escape back into the duct.

C. Fire Detector - Heat

1. Heat detectors shall be dual action electro-thermostatic combination rate of temperature rise and fixed temperature operation. An indicator shall be visible when detector has activated.
2. The rate of rise element shall be self-restoring, after activation.
3. The fixed temperature unit shall be set at 136 degrees F (190 degrees F for high temperature areas i.e. over 110 degrees F).
4. Provide a wire guard cover for the detector.

2.6 NOTIFICATION ALARM DEVICES

A. General

1. Notification alarm devices shall activate automatically from the control panel. Devices shall operate on a Class "B" (Style Y), 2-wire supervised alarm notification circuit. Series wired alarm devices shall not be used.
2. Numbered screw type terminals shall be provided for "in-out" connections of the alarm circuit wiring.
3. Devices shall be installed in a box, 3½-inches deep maximum, flush mounting unless indicated otherwise on the Drawings. Size as required for the alarm indicating device and wiring connections. Provide a trim ring and metal grill cover assembly. Cover assembly shall be a minimum of 1/16-inch minimum thick flat stainless steel or aluminum. Finish color as selected by Architect. The word "fire" shall appear on the grill minimum ½-inch letters. The grill shall be attached with screws to the box.
4. Each audible notification visual devices shall incorporate a visual alarm indicator. The visual alarm indicating device shall be an integral part of the audible alarm box assembly.
5. Audible notification device and visual notification devices shall be connected to separate notification alarm signal circuits. Do not connect these devices to the same circuit conductors.

B. Notification Appliances

1. Speakers

    Low Profile Speaker

    Provide low profile wall mount speakers at the locations shown on the Drawings. The low profile speaker shall not extend more than 1-inch (2.5cm) past the finished wall surface, and provide a switch selectable audible output of 2W (90dBA), 1W (87dBA), ½W (84dBA), or ¼W (81dBA) at 10 feet when measured in reverberation room per UL-464.

    Wattage setting shall be visible with the cover installed. When the cover is installed, no mounting hardware shall be visible. In and out screw terminals shall be provided for all wiring.

The low profile speaker shall mount in a North American 4-inches x 2⅛-inches square electrical box, without trims or extension rings.

2. Speaker-Ceiling Mount-8in
   Provide 8-inches ceiling mounted speakers at the locations shown on the Drawings. In and out screw terminals shall be provided for wiring. Speaker baffles shall be round or square steel with white finish as required. Provide square surface mount boxes with matching finish where required. Speakers shall provide ½w, 1w, 2w, and 4W power taps for use with 25V or 70V systems. At the 4 watt setting, the speaker shall provide a 94-dBA sound output a frequency of 1000Hz when measured in an anechoic chamber at 10 feet.
3. Speaker-Cone-4in
   Provide 4-inches white speakers at the locations shown on the Drawings. Speakers shall have a 4-inch Mylar cone, paper cones are not acceptable. The rear of the speakers shall be completely sealed protecting the cone during and after installation. In and out screw terminals shall be provided for wiring. Speakers shall provide ¼w, ½w, 1w, and 2w power taps for use with 25V or 70V systems. At the 2-watt setting, the speaker shall provide a 90-dBA sound output over a frequency range of 400-4000Hz when measured in reverberation room per UL-1480.
4. Speaker-Reentrant Surface
   Provide 4-inch surface re-entrant speakers at the locations shown on the Drawings. Speakers shall provide 2w, 4w, 8w, and 15w power taps for use with 25V or 70V systems. The re-entrant speakers shall utilize a high efficiency compression drivers. Cone type drivers are not acceptable. At the 15 watt setting, the speaker shall provide a 102dBA sound output over a frequency range of 400-4000 Hz when measured in reverberation room per UL-1480. Weatherproof boxes shall be provided for outdoor mounting.
5. Speaker-Strobes
   Low Profile Speaker-Strobe
   Provide low profile wall mount speaker/strobes at the locations shown on the Drawings. The low profile speaker/strobe shall not extend more than 1-inch (2.5cm) past the finished wall surface, and provide a switch selectable audible output of 2W (90dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (81dBA) at 10 feet when measured in reverberation room per UL-464. Strobes shall provide synchronized flash output that shall be switch selectable for output values of 15cd, 30cd, 75cd and 110cd. Wattage and candela settings shall be visible with the cover installed. When the cover is installed, no mounting hardware shall be visible. In and out screw terminals shall be provided for all wiring. The low profile speaker/strobes shall mount in a North American 4-inches x 2⅛-inches square electrical box, without trims or extension rings.
6. Speaker-Strobe 4in
   Provide 4-inches red speakers/strobes at the locations shown on the Drawings. Speakers shall have a 4-inches Mylar cone, paper cones are not acceptable. The rear of the speakers shall be completely sealed protecting the cone during and after installation. In and out screw terminals shall be provided for wiring. Speakers shall provide ¼w, ½w, 1w, and 2w power taps for use with 25V or 70V systems. At the 2 watt setting, the speaker shall provide an 87dBA sound output over a frequency range of 400-4000Hz when measured in reverberation room per UL-1480. Strobes shall provide synchronized flash. Strobe output shall be determined as required by its specific location and application from a family of 15/75cd, 30cd, and 110cd devices.
7. Speaker-Strobe Ceiling 8in
   Provide 8-inches ceiling mounted speaker/strobes at the locations shown on the Drawings. In and out screw terminals shall be provided for wiring. Speaker baffles shall be round or square, steel with white finish as required. Provide square surface mount boxes with matching white finish as required. Speakers shall provide ½w, 1w, 2w, and 4W power taps for use with 25V or 70V systems. At the 4 watt setting, the speaker shall provide a 94dBA sound output a frequency of 1000Hz when measured in an anechoic chamber at 10 feet. Strobes shall provide synchronized flash outputs. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 75cd, and 110cd devices.
8. Speaker-Strobe Re-entrant
   Provide 4-inch red re-entrant speaker/strobes at the locations shown on the Drawings. Weatherproof boxes shall be provided for outdoor mounting. Speakers shall provide 2w, 4w, 8w, and 15w power taps for use with 25V or 70V systems. The re-entrant speakers shall utilize a high efficiency compression drivers. Cone type drivers are not acceptable. At the 15-watt setting, the speaker shall provide a 102dBA sound output over a frequency range of 400-

4000Hz when measured in reverberation room per UL-1480. Strobes shall provide synchronized flash. Strobe output shall be determined as required by its specific location and application from a family of 15cd, 30cd, 75cd, and 110cd devices.

C. Visual Alarm Indicator
   1. Lamp/Strobe internally illuminated projecting lens assembly, with flasher system. Unit shall flash on and off to provide visual indicating of fire alarm.
   2. The word "fire" shall appear on the lens or lens plate.
   3. Flash rate, one flash per second, with a flash duration of approximately 0.001 second, flash rate independent of audible device.
   4. Light source, Xenon high intensity flash strobe tube white/clear color.
   5. Strobe shall have a minimum output of 75 candelas with a maximum flash intensity of 120 candelas.
   6. Strobe shall comply with NFPA requirements.

2.7 REMOTE FIRE ALARM ANNUNCIATOR

A. General
   1. The annunciator panel shall be powered and operated from the fire alarm control panel. "In-out" circuit conductors shall terminate on numbered screw-type terminals.
   2. A metal tamper resistant weatherproof cabinet shall contain the annunciator components. The panel shall be surface or flush mounted as indicated on the Drawings. Provide a full height tamper resistant, hinged locking cabinet door. Door shall have transparent high impact windows to allow visual observation of all indicators and switches.
   3. An electronic digital, multiplex, addressable module shall be incorporated into the annunciator. The module shall communicate the status and trouble condition of each device with a unique Address Code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Each Alarm Initiating Zone (including spares) shall be individually annunciated in the annunciator panel.

C. A Common Fire Trouble Alarm shall be annunciated in the annunciator panel from the fire alarm control panel.

D. Annunciator Lamp Circuits shall be automatically supervised. Provide lamp test switch in the annunciator panel.

E. An Audible Alarm/Trouble Buzzer with silence switch and automatic resound for subsequent alarm/trouble signals shall be provided. The annunciator panel shall be automatically reset when the control panel is reset.

F. A Keyed Switch shall be provided for remote reset of the system. The annunciation panel shall also be automatically reset when the control panel is reset.

G. Provide a Floor Plan of the facility framed under acrylic and mounted adjacent to the fire alarm annunciator. The Floor Plan shall be to scale and shall have room numbers clearly displayed on all rooms corresponding to the annunciator for the purpose of easily identifying the fire zones.

2.8 REMOTE EQUIPMENT MONITORING AND CONTROL

A. An Electronic Digital Multiplex Addressable Module shall be provided at each device or equipment indicated to be controlled by the multiplex system. Multiple addressable control ports shall be provided in each module quantity as required for each point controlled or monitored. The module shall communicate the monitor status control action and trouble condition of each device with a unique Address Code. The module shall communicate with and be supervised and monitored by the fire alarm control panel.

B. Where Multiple Points are Monitored or Controlled, Provide Digital, Multiplex, Multi-Points, Monitor, Control Panel (MMCP). The panel cabinet shall be self-contained NEMA 1 construction and hinged locking door. Provide tamper switch detection zone on the cabinet door; provide 60 hour battery

UPS backup and power supply, the same as required for the fire alarm control panel. Panel shall be expandable using plug-in circuit monitor/control printed circuit cards. Provide barriered numbered terminal strips.

C. Each Control Point shall provide a supervised "dry" relay contact single pole double throw maintained contact rated 10 ampere, 227 volt, 60Hz AC.

D. Each Monitor Point shall provide not less than one of the following supervised methods of monitoring a remote device or equipment action or status.

1. Remote "dry" contact operation normal open, normally closed or momentary contact operation.

PART 3 EXECUTION

3.1 IDENTIFICATION

A. The Inside Cover of Alarm Initiating Devices shall be marked with the zone initiating number corresponding to the zone number in the control panel. Marking shall be with a felt-tip pen.

B. Each Fire Alarm Terminal Cabinet shall be painted red.

C. Provide Nameplate: "Power to Main Fire Alarm Control Panel" screwed onto the branch circuit overcurrent device supplying power to the main fire alarm control panel.

3.2 WIRING

A. Review the Total System Point-to-Point Wiring layout to assure that the correct number and type of wires and conduit sizes are installed.

B. Final Connections, Testing, Adjusting and Calibration shall be made under the direct supervision of a Factory-Trained Technician of the System Supplier.

C. All Wiring shall be in conduit.

D. All Wiring in Cabinets shall be neatly formed, laced and made up on bolt and nut terminal blocks. Tag all spare conductors. All conductors shall terminate on terminal strips with spade lugs, of adequate size for all incoming and outgoing conductors. The strips shall be labeled as to their use and wiring diagram shall be placed on the cabinet door showing connections of all related equipment to these strips.

E. Wiring Requirements for shielding certain conductors shall be as recommended by the Manufacturer. Provide all conduit, raceways and conductors per Manufacturers recommendations and include all material and labor costs in the Contract Price.

F. The Conductors used for digital, multiplex communication between the fire alarm control panel and external remote initiation devices, control points and annunciators, shall be twisted, shielded, multi-conductor cable, #16AWG copper minimum with a separate internal ground/drain conductor, UL listed for fire alarm system use. One spare pair of multiplex conductors shall be provided in all main and branch device/equipment connections for future system use. "Tees" and taps at any junction box location in the communication lines, shall be permitted by the system to additional devices without affecting proper system operation.

G. Wire Size: Wire shall be sized to insure installed circuit voltage drop does not exceed 10% to all devices.

3.3 OUTLET BOXES

Device outlet boxes shall be flush mounted unless indicated otherwise on the Drawings. Provide extension rings to finish flush with finish surface. Where the Drawings indicate surface mounted devices, outlet boxes shall be cast metal with threaded hubs. Where the conduit entrances are not exposed for surface mounted devices, provide flush outlet box behind the device box, and omit the

conduit hubs on the device box. Size device boxes and outlet boxes per Manufacturer's recommendation and as required by Code for wire fills.

3.4 SPECIAL INSTALLATION REQUIREMENTS

A. Air Duct Smoke Detectors shall be installed in the supply air ducts and return air ducts with an air flow of 2000 CFM or greater, coordinate with Mechanical Contractor. Sampling tube shall extend across entire duct width. Provide ¾-inch conduit with 2#12 to respective motor control device to automatically shut down the respective fan motor upon detection of smoke in the air duct. Installation shall be in compliance with CMC 606.8.

B. Water Flow Switches shall be installed on each main fire sprinkler rise pipe, coordinate with the Fire Sprinkler Contractor.

C. Tamper Switches shall be installed on each main fire sprinkler shut-off valve, coordinate with the Fire Sprinkler Contractor.

D. Equipment shall be weatherproof gasketed where installed in locations exterior to the building, or where indicated on the Drawings. Weatherproof equipment shall be tamper resistant.

E. Provide Clear Vandal Resistant Protective Cover for all audio-visual devices located in student restrooms and public hallways.

F. Provide Wire Guard for Ceiling mounted smoke and heat detectors located in student restrooms.

G. Connect Fire Alarm Control Panel with Security/intrusion control panel for monitoring by Remote Monitoring Company.

H. Connect Fire Alarm Control Panel with Master Clock System to turn off class passing schedule, with paging system to turn off system when fire alarm system in alarm condition.

I. Conduit with Fire Alarm Wiring shall be painted red.

J. Fire Alarm System shall be programmed per actual building and room designation. Submit printout for review.

3.5 TESTING

A. The Entire Fire Alarm System shall be tested in the presence of the Local DSA Inspector and a Representative of the Manufacturer after the installation is complete.
   1. Individually activate each manual initiating station and verify correct alarm operation and control panel response.
   2. Individually test each automatic initiating device and verify correct alarm operation, control panel response and remote equipment operation.
   3. The communication loops and the notification alarm circuits shall be opened in at least two locations per building to check for the presence of correct supervisory circuitry.

B. Test the Battery Back-up System by disconnecting the incoming normal power and allowing this alarm system to operate 24 hours on battery power. Sound the alarm system for 5-minutes at the end of 24 hours on battery power.

C. Perform all Electrical and Mechanical Tests required by the Equipment Manufacturer's Certification form. Measure and adjust each automatic detection detector to the maximum stable sensitivity setting. Detector tests shall be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable. An operational check-out test and report shall be performed. Submit six copies of test report results. The tests and report shall include, but not be limited to:
   1. A complete list of equipment installed and wired.
   2. Indication that all equipment is properly installed and functions and conforms with these Specifications.
   3. Test of individual zones as applicable.

4. Serial numbers locations by zone and model number for each installed detector.
5. Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
6. Technician's name, certificate number and date.
7. The completed manual and automatic monitoring and control system shall be tested to insure that it is operating properly. This test will consist of exposing the installed units to a standard fire test.
8. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a 90-day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Contractor shall readjust or replace the equipment and detector(s) and begin another 90-day test period. As required by the Architect, the Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the District has obtained beneficial use of the building under tests.

D. After the Testing has been completed to the satisfaction of CFC 907.9 – 907.9.4.1 the Inspectors, provide the NFPA Certificate of compliance to the District, the Local Fire Official, the Architect and DSA.

E. Upon the receipt of Certificate of Compliance, the Installer/Supplier shall supply the District with a Written Operating, Testing and Maintenance Instructions, Point-to-Point As-Built Drawings, and Equipment Specifications. Maintenance provisions, CFC 907.4.5.

3.6 INSTRUCTIONAL SESSIONS

Provide a 2-hour Instructional Sessions conducted by a Factory-Authorized Technician at the Job Site after completion of all tests to instruct District Personnel on the use of the system. The first session shall be videotaped and conducted prior to final acceptance of the Project. The second session shall be held within 11-months of final acceptance of the Project, when requested by the District.

END OF SECTION 283100
070317/1010006

SECTION 312000
EARTH MOVING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses and exterior plants.
   2. Excavating and backfilling for buildings and structures.
   3. Drainage course for slabs-on-grade.
   4. Base course for concrete, walks and pavements.
   5. Base course for asphalt paving.
   6. Excavating and backfilling for utility trenches.

1.2 QUALITY ASSURANCE

A. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC), latest edition and supplements for rock materials. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

1.3 REFERENCES

A. This specification section has been prepared using the project soils report by Terracon Consultants dated June 27, 2016 as a reference.

1.4 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subgrade and hot-mix asphalt or concrete paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Classified Excavation: Removal and disposal of materials not defined as rock

F. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
   2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.

K. Unclassified Excavation: Removal and disposal of materials encountered regardless of nature of materials, including rock.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 PROJECT CONDITIONS

A. Examine site, Drawings, records of existing utilities and construction, record of test borings, and subsurface exploration report available from Owner. Records of test borings are for information only and are not guaranteed to represent all conditions that will be encountered.

1.6 PROTECTION

A. Soils Consultant: A geotechnical consultant shall advise on Construction techniques involved in work, including design, checking and approving of temporary bracing, sheeting, shoring, underpinning and other items pertinent to work, and encountered during prosecution of work. Consultant shall be primarily concerned with construction methods, which will prevent settlement or damage to surrounding structures, sidewalks, embankments, utilities and roads on Owner's property and adjoining properties.

B. Existing Utilities:

1. Maintain existing utilities that are to remain in service. Before excavating over or adjacent to existing utilities, notify utility Owner to ensure protective work will be coordinated and performed in accordance with utility Owner's requirements. If existing service lines, utilities and utility structures, which are to remain in service, are uncovered or encountered during these operations, safeguard and protect from damage.
2. Within limits of excavation, remove existing piping, subsoil drainage systems, conduit, manholes and relocated items, which are to be abandoned. Plug open ends of utilities to remain with concrete.
3. Re-route existing subsoil drains which obstruct work around new constructions, or incorporate them into new drainage systems.
4. Consult Architect immediately for directions, should uncharted or incorrectly charted piping or other utilities be encountered during excavation. Cooperate with Owner and public and private utility companies in keeping their respective services, utilities and facilities in operation. If damaged, repair utilities to satisfaction of Architect and utility Owner.

C. Existing Facilities: Protect and maintain in satisfactory manner, existing pavements, curbs, gutters, structures, conduits, fences, walls and other facilities to remain above and below grade. Restore facilities damaged by construction operations.

D. Pumping and Draining: Excavate areas in such manner as to afford adequate drainage. Control grading in vicinity of excavated areas so ground surface will slope to prevent water running into excavated areas. Until work is completed, remove water from areas of construction that may interfere with proper performance of work or that may result in damage to the soil sub-grade and provide sumps, pumps, well points, electric power and attendance required for this purpose on a 24 hour basis if necessary. Protect construction from water during construction, including prevention of erosion of completed work during construction and until permanent drainage and erosion controls are operational. Repair adjoining properties, facilities and streets damaged due to improper protection.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Sand, gravel, friable earth, or non-expansive clays, subject to Testing Laboratory's approval. Fill and backfill material shall be free of organic material, slag, cinders, expansive soils, trash or rubble and stones having maximum dimension greater than six inches.

C. Unsatisfactory Soils: Expansive and other soils as defined in the project's geotechnical investigation report.

1. Unsatisfactory soils also include satisfactory soils not maintained within two percent of optimum moisture content at time of compaction.

D. Base Course: Material conforming to SSPWC section 200-2.2, Crushed Aggregate Base or SSPWC section 200-2.4 Crushed Miscellaneous Base.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a one and one-half inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Bedding Course: Naturally or artificially graded clean, crushed sand; ASTM D 2940; except with 100 percent passing a 3/8-inch sieve and not more than eight percent passing a No. 200 sieve.

G. Drainage Course: Narrowly graded mixture of washed, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a one and one-half inch sieve and zero to five percent passing a No. 8 sieve.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, six inches wide and four mils thick, continuously inscribed with a description of the utility. Color coding shall be according to the American Public Works Association (APWA) standards:

1. Blue – Potable water and fire suppression lines.
2. Green – Sanitary sewer and storm drain lines
3. Orange – Communication, alarm or signal lines
4. Purple – Reclaimed water, irrigation, and slurry lines
5. Red – Electrical power lines, cables, conduit and lighting lines
6. Yellow – Gas, oil, hydronic chilled water, steam, petroleum, or gaseous material lines

PART 3 EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing" or "Demolition".

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing" or "Demolition," during earthwork operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide six-inch clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches six inches deeper than elevation required in rock or other unyielding bearing material, four inches deeper elsewhere, to allow for bedding course.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2,500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section Cast-in-Place Concrete.

D. Provide four-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of four inches of concrete before backfilling or placing roadway base.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than one inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, minimum 6 inches above top of pipe, minimum 12 inches below finished grade, except six inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use engineered fill.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within two percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by two percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than eight inches in loose depth for material compacted by heavy compaction equipment, and not more than four inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material to 95 percent.
   2. Under walkways, scarify and recompact top six inches below subgrade and compact each layer of backfill or fill soil material to 90 percent.
   3. Under lawn or unpaved areas, scarify and recompact top six inches below subgrade and compact each layer of backfill or fill soil material to 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material to 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: Plus or minus one inch.
   2. Walks: Plus or minus one inch.
   3. Pavements: Plus or minus one-half inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of one-half inch when tested with a 10-foot straightedge.

3.14 BASE COURSES

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:
   1. Shape base course to required crown elevations and cross-slope grades.
   2. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course that exceeds six inches in compacted thickness in layers of equal thickness, with no compacted layer more than six inches thick or less than three inches thick.
   2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 316329
DRILLED CONCRETE PIERS AND SHAFTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Dry-installed drilled piers.
2. Slurry displacement-installed drilled piers.
3. Dry-installed or slurry displacement-installed drilled piers, at Contractor's choice.

B. Related Sections include the following:

1. Division 03 Section “Cast in Place Concrete” for general structural and building applications of concrete.
2. Division 03 Section “Concrete Reinforcement.”

1.3 REFERENCES

A. Standards listed below apply where designation is cited in this Section. Where the applicable year of adoption or revision is not listed below, the latest edition applies.

B. American Concrete Institute (ACI): Use applicable year of adoption or revision as published in the “ACI Manual of Concrete Practice”.

1. ACI 336.1: Standard Specification for the Construction of Drilled Piers.

C. American Society for Testing and Materials (ASTM): Use applicable year of adoption or revision as published in the “Annual Book of ASTM Standards”.

1. ASTM A 252: Specification for Welded and Seamless Pipe Piles.
2. ASTM A 36: Standard Specification for Carbon Structural Steel.

D. CBC: 2013 California Building Code

E. Evaluation Report: Where designated in this Section, products shall have an active Evaluation Report evidencing compliance with provisions of the International Building Code. Reports are available at www.icc-es.org and www.iapmoes.org.

F. Geotechnical Report:

1.4 SUBMITTALS

A. Submittal procedures and administrative provisions are established by Division 01 Section "Submittals".

B. Product Data: For each type of product indicated.

C. Design Mixes: For each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

D. Shop Drawings: For concrete reinforcement detailing fabricating, bending, and placing.

E. Shaft Drilling Reports: Record of as-built pier location, diameter, tip elevation, cut off elevation, reinforcing and concrete placement.

F. Submit pier installation and proposed temporary shaft protection plan to the Owner's Geotechnical Engineer at least four weeks prior to mobilization.

1. The installation and shaft protection plan shall provide information on the following:

a. Name and experience record of the drilled pier superintendent who will be in charge of drilled pier operations for the project.

b. List of proposed equipment to be used, including cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, core sampling equipment, tremies, concrete pumps, casing.

c. Details of overall construction operation sequence and the sequence and schedule of shaft construction.

d. Details of shaft excavation methods.

e. When the use of slurry is anticipated, details of the mix design and its suitability for the subsurface conditions at the construction site, mixing and storage methods, maintenance methods, disposal procedures, slurry mixing procedures, pumping and handling equipment, testing procedures, slurry cleaning procedures, recycling and disposal procedures.

f. Details of methods to clean the shaft excavation.

g. Details of reinforcement placement, including support and centralization methods.

h. Details of concrete placement, including proposed operational procedures for free fall, tremie or pumping methods.

i. Details of casing installation and removal methods.

2. The Geotechnical Engineer will evaluate the drilled pier installation plan for conformance with the plans, specifications and special provisions. Within 14 days after receipt of the installation plan, the Geotechnical Engineer will notify the contractor of any additional information required and or changes necessary to meet the contract requirements. All procedural approvals given by the Geotechnical Engineer shall be subject to trial in the field and shall not relieve the Contractor of the responsibility to satisfactorily complete the work as detailed in the plans and specifications.

G. Submit a survey plan locating new drilled piers after installation. Actual pier locations and pier reinforcement to be coordinated with pier cap reinforcement.

H. Submit a concrete placement procedure for drilled piers for 30 minutes maximum interruption of placement. The procedure shall include a contingency plan that gives an additional 15 minutes of interruption of placement.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications:

1. Minimum of 3 successful projects with similar soil conditions, shaft sizes, depth and volumes of work contained in this project.

2. Submit proof of compliance within 30 days after "Notice to Proceed."

B. Survey Work: Engage a California licensed land surveyor to perform surveys, layouts and measurements for drilled pier work.

1. Conduct layout work for each pier to lines and levels required before excavation and actual measurements of each pier's horizontal axial location, shaft diameter, bottom and top elevations, deviations from specified tolerances and other data as required.
2. Record and maintain information pertinent to each pier and cooperate with other testing and inspection personnel to provide data required for reports.
3. The Owner's Geotechnical Engineer will inspect shafts prior to and after the installation of reinforcement, test soil materials and verify pier depth. The Geotechnical engineer will also inspect shafts prior to concrete placement.
4. If the Geotechnical Engineer's inspection determines that there is loose material in the shaft excavation, the Contractor will clean the hole as directed by the Geotechnical Engineer, including the removal of the reinforcing cage as required.
5. The Owner's Testing Agency will inspect installation of reinforcing and placement of concrete in drilled piers.
6. Materials and installed work may require testing and retesting at any time during the progress of work. Allow free access to material stockpiles and facilities.

1.6 PROJECT CONDITIONS

A. Subsurface Information: Refer to Geotechnical Report.

B. Existing Utilities: Locate existing underground utilities by careful hand excavation before starting shaft excavation operations.

1. If utilities are to remain in place, provide protection from damage during construction operations.
2. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult Owner immediately for directions as to procedure.
3. Cooperate with Owner and public and private utility companies in keeping their respective service and facilities in operation at all times.
4. Repair damaged utilities to the satisfaction of the utility owner.
5. Do not interrupt existing utility serving facilities occupied and used by Owner or others, except where permitted in writing by Owner's Representative and then only after acceptable temporary utility services have been provided.

C. Environmental Requirements: Groundwater is expected to be encountered during drilling. See Geotechnical Report for expected depth.

1. Provide adequate temporary drainage to prevent shaft instability.
2. Pump shafts when directed by the Geotechnical Engineer.

D. Barricade excavations as required in accordance with Division 1 Section "Temporary Facilities and Controls."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete Reinforcement: See Division 3 Section "Concrete Reinforcement."

B. Concrete Materials: See Division 3 Section "Cast-in-Place Concrete."

C. Steel Pipe Casings: ASTM A 283, Grade C; or ASTM A 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1.

D. Slurry: Pulverized sodium bentonite, pulverized attapulgite, or polymers, mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH. Super Mud manufactured by PDS Company Inc. or approved equal. To be used in accordance with manufacturer's recommendations.

E. Concrete Mix:

1. Prepare design mixes according to ACI 211.1 and ACI 301 for each type and strength of concrete determined by either laboratory trial mix or field test databases. Mix designs shall be stamped and signed by a registered Civil or Structural engineer licensed in the state of California. Contractor shall bear all costs for concrete mix designs.

    a. Use a qualified testing agency for preparing and reporting proposed mix designs for laboratory trial mix basis.

2. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:

    a. Compressive Strength (28 Days): 4,000 psi.

    b. Minimum Slump: Capable of maintaining the following slump until completion of placement:

        1) 4 inches for dry, uncased, or permanent-cased drilling method.

        2) 6 inches for temporary-casing drilling method.

        3) 7 inches for slurry displacement method.

F. Do not air entrain concrete for drilled piers.

G. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.

H. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

I. Concrete-mix design adjustments may be considered if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant. Resubmit and obtain approval of proposed changes to concrete-mix proportions

PART 3 - EXECUTION

3.1 DESIGN

A. Construct pier reinforcement cage per contract documents and to allow for insertion of a tremie tube for concrete placement. Reinforcing cage shall be free of irregularities that could interfere with insertion and removal of the tremie.

3.2 EXAMINATION

A. Examine site conditions prior to commencement of drilling shafts.

B. Notify immediately the Owner's Representative in writing in the event of unsatisfactory site conditions, indicating the nature of extent of unsatisfactory conditions.

C. Protect adjacent affected structures from damage.

D. Notify the Owner's Representative at least two workdays prior to commencing work.

3.3 SHAFT EXCAVATION

A. Excavate shaft for piers to lengths shown on the drawings. Pier holes shall be reamed with a bucket and auger prior to steel reinforcement cage installation.

1. Excavate shafts only after adjacent holes with 3 pier diameters are filled with concrete and allowed to set for at least 24 hours.

B. Temporary Shaft Protection:

1. Temporary shaft protection is the responsibility of the contractor.
2. Temporary casing and/or drilling slurry shall be required for shaft protection of piers extending below the water table.
3. Temporary casings shall have sufficient thickness to withstand compressive and withdrawal stresses as required to maintain shaft walls without displacing.
4. Remove and replace or repair casings which are damaged during installation and which could impair the strength or efficiency of the completed pier.
5. Remove all casings after placing concrete.
6. The drilling slurry shall be maintained at least six feet above the groundwater level in order to provide adequate support to soil on the walls of the drilled pier excavations.
7. Drilling slurry shall be mixed in external tanks with adequate agitation for the slurry to become uniformly mixed, self-suspending and free of lumps. The slurry shall be mixed in accordance with the manufacturer's recommendations. pH and marsh funnel viscosity testing of the slurry shall be performed before introducing slurry to the drilled hole.
8. During drilling and prior to concrete placement, slurry shall be sampled from the top and bottom of each pier excavation using a double ball bailer. The slurry samples shall be tested for pH, marsh funnel viscosity, sand content and specific weight to confirm that the slurry properties are within the range of the manufacturer's recommendations. Slurry mix testing shall be performed by individuals trained by the manufacturer's representative. Slurry may be recycled for use on subsequent piers.

C. Construction Tolerances:

1. Maximum permissible variation of location at top of pier: Not more than 1/24 of the shaft diameter or 3 inches, whichever is less.
2. Maximum shaft out-of-plumb: Not be more than 1.5 percent of length nor exceeding 12.5 percent of shaft diameter or 15 inches, whichever is less.
3. Concrete cut-off elevation: Plus 1 inch or minus 3 inches.
4. If above tolerances are exceeded, provide additional or corrective construction to compensate for excessive eccentricity.
5. Submit proposed corrective construction methods to Owner's Representative for review before proceeding.

D. Obstructions:

1. Use core barrels with drilling equipment, hand labor using air-powered tools or other safe methods to remove rock, boulders and obstructions.
2. Dispose of excavated material in accordance as required by the Specifications.

3.4 DEWATERING

A. Comply with requirements of Division 1 Section "Temporary Facilities and Controls."

3.5 OVER EXCAVATION

A. No payment will be made for extra length when shafts are excavated to a greater depth than required or authorized by the Owner's Geotechnical Engineer, due to overdrilling by the Contractor.

B. Complete pier depth and fill extra depth with approved concrete if other conditions are satisfactory.

3.6 REINFORCING STEEL

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement. See Division 3 Section “Concrete Reinforcement.”

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover to reinforcement. Use 4 approved spacers equally spaced around the cage. Longitudinal spacing shall not be more than 10-15 feet between spacers to be tied to the cage.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather and to ensure smooth movement of the tremie.

G. Reinforcing cages must be placed in the same shift that concrete placement occurs. Cages will not be allowed to stay in the hole until the next work shift. Reaming shaft, inspection of shaft, placement of cage, final inspection of shaft and concrete placement should take place in continuous sequence of operations without interruption.

3.7 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner’s Geotechnical Engineer, Owner's independent testing and inspecting agency. Provide protection sheets extending at least 12 inches beyond the edges of excavation opening.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

   1. Where concrete cannot be directed down shaft without striking reinforcing, place concrete with chutes, tremies, or pumps.

   2. Vibrate top 60 inches of concrete.

C. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches into concrete, and flow of concrete is continuous from bottom to top of drilled pier without segregating the mixed materials.

D. Maintain sufficient pressure head of concrete to prevent reduction in diameter of shaft by earth pressure and to prevent extraneous material from mixing with fresh concrete.

E. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch head of concrete above bottom of casing.

F. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

G. Interrupted placing operations of over 45 minutes shall not be permitted.

H. Remove excess laitance and slurry contaminated concrete using vacuum truck or other approved means to cut off elevation and backfill hole to working grade with clean sand.

I. Hot and Cold Weather Placement: Provide in accordance with provisions of Division 3 Section "Cast-in-Place Concrete."

3.8 FIELD QUALITY CONTROL

A. Provide field quality control testing and inspection for concrete and reinforcing steel as specified in Division 3 Section "Concrete Reinforcement" and Section "Cast-in-Place Concrete."

B. Notify Owner and Geotechnical Engineer at least 48 hours prior to time that excavations will be ready for inspection and tests.

C. Provide facilities as required to assist inspection and testing of excavations and cooperate with inspecting and testing personnel to expedite work.

D. Geotechnical Engineer:

1. Inspect and report results.
2. Conduct inspections and provide reports as soon as possible so as not to delay concrete placement for acceptable excavations.
3. Inspect shaft borings prior to installation of reinforcement, test soil materials and confirm pier depth.

E. Owner's Testing Agency:

1. Inspect placement of reinforcement per Division 3 Section "Concrete Reinforcement."
2. Inspect placement of concrete per Division 3 Section "Cast-in-Place Concrete."

F. Perform slurry testing and provide results to Owner in accordance with approved Pier Installation Plan.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes hot-mix asphalt paving, patching and paving overlay.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Material certificates.

D. Log of placement of asphalt, including dates, times, temperature readings and other pertinent information.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Standard Specifications: Comply with the Standard Specifications for Public Works Construction (SSPWC) and the California Department of Transportation (Caltrans), latest editions and supplements for asphalt paving work. These Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and payment sections do not apply to this document.

C. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
   1. Tack Coat: Minimum surface temperature of 60 degrees Fahrenheit.
   2. Asphalt Base Course: Minimum surface temperature of 40 degrees Fahrenheit and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 degrees Fahrenheit at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees Fahrenheit for oil-based materials, 50 degrees Fahrenheit for water-based materials, and not exceeding 95 degrees Fahrenheit.

PART 2 PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: Crushed rock conforming to SSPWC 400-4.2.3.

B. Fine Aggregate: Sand, rock dust, mineral filler, or a blend of these materials conforming to SSPWC 400-4.2.4. Mineral filler, if required, shall conform to SSPWC section 203-6.2.3.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: Paving asphalt, viscosity grade PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.

B. Tack Coat: PG 64-10 conforming to Section 92 of the Caltrans Standard Specifications.

C. Mixes: Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mix III-C3 PG 64-10 designed in conformance with SSPWC Section 400-4.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.
   1. Color: White, Yellow and Blue per Federal Standard 595 Color 15090).

C. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized.
   1. Dowels: Galvanized steel, three-fourths-inch diameter, 24-inch minimum length.

PART 3 EXECUTION

3.1 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
   1. Mill to a depth of not less than one and one-half inches.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gallons/square yard.

C. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
   1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gallons/square yard.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at minimum temperature of 250 degrees Fahrenheit.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 degrees Fahrenheit.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

F. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus one-half inch.
   2. Surface Course: Plus one-fourth inch (no minus).

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: One-fourth inch.
   2. Surface Course: One-eighth inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is one-fourth inch.

3.7 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.8 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel one inch beneath top of wheel stop.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in a landfill by the Environmental Protection Agency (EPA).

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:
   1. Driveways and roadways.
   2. Parking lots.
   3. Curbs and gutters.
   4. Walkways.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, including admixtures.

B. Design Mixtures: For each concrete pavement mixture.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

C. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction (SSWPC), latest edition and supplements.

D. The Contractor shall have one copy of the Standard Specifications at the job site.

E. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.

PART 2 PRODUCTS

2.1 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice."

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:
   1. Portland Cement: ASTM C 150, Type II, low alkali. Supplement with the following:
      a. Pozzolan: ASTM C618, Class F or N Fly Ash, 100 pounds maximum per cubic yard, containing one percent or less carbon. Fly ash shall not be used in excess of 15 percent by weight of total cement quantity.

B. Combined Aggregates: Gradation “C” conforming to SSPWC Section 201-1.3.2.

C. Water: ASTM C 94/C 94M.

2.3 CURING MATERIALS

A. Liquid Curing Compound: ASTM C309, fugitive dye dissipating type, complying with Rule II 13 of the South Coast Air Quality Management District and Federal Air Quality Regulation 40 CFR 52.254.

B. Moisture-Retaining Cover (Curing Sheet): ASTM C 171, non-staining polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

2.4 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than 45 minutes.

1. Color: As indicated.

2.5 WHEEL STOPS

A. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized.

1. Dowels: Galvanized steel, three-fourths-inch diameter, 24-inch minimum length.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, with the following properties:

1. Compressive Strength (28 Days): 2,500 pounds per square inch (psi) to 3,500 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45
3. Slump Limit: Four inches, plus or minus one inch.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates to Architect for each batch discharged and used in the Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and control joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

D. Control Joints: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of the concrete thickness to match jointing of existing adjacent concrete pavement.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a one-fourth-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed pavement surfaces with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on pavement surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds/square feet by h before and during finishing operations. Apply according to manufacturers written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these methods.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances as follows
   1. ACI 117 establishes few pavement tolerances; those in subparagraphs below are based on ACI 330.1.
   2. Elevation: One-fourth inch
   3. Thickness: Plus three-eighths inch minus one-fourth inch
   4. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed one-fourth inch.
   5. Joint Spacing: Three inches.
   6. Contraction Joint Depth: Plus one-fourth inch no minus.
   7. Joint Width: Plus one-eighth inch, no minus.

3.9 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.10 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded in holes drilled or cast into wheel stops at one-quarter to one-third points. Firmly bond each dowel to wheel stop and to pavement. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel 1 inch beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement.

C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 321373
CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Expansion and isolation joints within cement concrete pavement.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Compatibility and Adhesion Test Reports: From sealant manufacturer.

1.3 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
   1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 COLD-APPLIED JOINT SEALANTS

A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
   1. Products:
      a. Crafco Inc.; RoadSaver Silicone.
      b. Dow Corning Corporation; 888.
      c. Or any equivalent product.

B. Type SL Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
   1. Products:
      a. Crafco Inc.; RoadSaver Silicone SL.
      b. Dow Corning Corporation; 890-SL.
      c. Or any equivalent product.

2.4 HOT-APPLIED JOINT SEALANTS

A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.

1. Products:
    a. Crafco Inc.; Superseal 444/777.
    b. Meadows, W. R., Inc.; Poly-Jet 3406.
    c. Or any equivalent product.

2.5 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

PART 3 EXECUTION

3.1 INSTALLATION

A. Concrete curing requirement: The concrete must be allowed to cure and dry a minimum of 7 days in good drying weather before installing sealant. An additional day of good drying weather must be allowed for each day of poor, inclement weather.

B. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience.

D. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

E. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

F. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

H. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

END OF SECTION

SECTION 321400
UNIT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interlocking Concrete Paver Units (manually installed).
   2. Bedding and Joint Sand.
   3. Edge Restraints.
   4. Cleaner, Sealers, and Joint sand stabilizers.

B. Contractor's bid shall include all materials and services referenced in the Drawings and these Specifications, and shall be responsible for review and completion all these specification instructions herein.

C. Related Sections:
   1. Section 129300 - Site Furnishings
   2. Section 328400 - Irrigation Systems
   3. Section 329000 - Planting
   4. Section 329400 - Landscape Maintenance

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM C 33, Standard Specification for Concrete Aggregates.
   2. C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile, Section 8, Freezing and Thawing.
   3. ASTM C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. ASTM C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   5. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
   6. ASTM C 936, Standard Specification for Solid Concrete Interlocking Paving Units.ASTM C 979, Standard Specification for Pigments for Integrally Colored Concrete.
   7. ASTM D 698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft3 (600 kN-m/m3)).
   8. ASTM D 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   9. ASTM D 2940, Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports.
   10. Interlocking Concrete Pavement Institute (ICPI):
   11. ICPI Tech Spec Technical Bulletins

1.3 SUBMITTALS

A. In accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Sieve analysis per ASTM C 136 for grading of bedding and joint sand.

C. Concrete pavers:
   1. Four (4) representative full-size samples of each paver type, thickness, color, finish that indicates the range of color variation and texture expected in the finished installation.
   2. Accepted samples become the standard of acceptance for the work.
   3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
   4. Manufacturer's certification of concrete pavers by ICPI as having met applicable ASTM standards.
   5. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

D. Paver Installation Subcontractor:
   1. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.
   2. Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

E. Materials to be furnished:
   1. As part of this contract: upon completion of work for this section of the contract the contractor shall supply the following item to the District Representative:
      a. 400 square feet of paver field color of each type used, per the Construction legend and record drawings.
      b. 200 square feet of paver band colors of each type use, per the Construction legend and record drawings.
      c. Pavers shall be from the same production run as installed materials.

1.4 QUALITY ASSURANCE

A. Paving Subcontractor Qualifications
   1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.
   2. Utilize an installer holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

B. Mock-Ups
   1. Install a Mock up paver area.
   2. Use this area to determine surcharge of the bedding sand layer, joint sizes, lines, laying pattern(s), color(s) and texture of the job.
   3. This area will be used as the standard by which the work will be judged.
   4. Subject to acceptance by owner, mock-up may be retained as part of finished work.
   5. If mock-up is not retained, remove and properly dispose of mock-up.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers packaging with identification labels intact.
   1. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
   2. Deliver concrete pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
   3. Unload pavers at job site in such a manner that no damage occurs to the product.

D. Storage and Protection: Store materials protected such that they are kept free from mud, dirt, and other foreign materials. Store concrete paver cleaners and sealers per manufacturer's instructions.
   1. Cover bedding sand and joint sand with waterproof covering if needed to prevent exposure to rainfall or removal by wind. Secure the covering in place.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not install sand or pavers during heavy rain
   2. Do not install saturated sand.
   3. Do not install concrete pavers on saturated sand.

PART 2 PRODUCTS

2.1 INTERLOCKING CONCRETE PAVERS

A. Interlocking Concrete Pavers by Ackerstone or approved equal:

1. Paver Type: As specify on construction drawings.
   a. Material Standard: Comply with material standards set forth in ASTM C 936.
   b. Color Pigment Material Standard: Comply with ASTM C 979.
   c. Average Compressive Strength (C140): 8000 psi (55 MPa) with no individual unit under 7200 psi (50 MPa) per ASTM C 140.
   d. Average Water Absorption (ASTM C 140): 5% with no unit greater than 7%.
   e. Freeze/Thaw Resistance (ASTM C 67): Resistant to 50 freeze/thaw cycles with no greater than 1% loss of material. Freeze-thaw testing requirements shall be waived for applications not exposed to freezing conditions.

2.2 PRODUCT SUBSTITUTIONS

1. Substitutions: No substitutions permitted.

2.3 BEDDING SAND

1. Bedding sand as follows:
   a. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
   b. Do not use limestone screenings, stone dust, or sand for the bedding sand material that does not conform to conform to the grading requirements of ASTM C 33.
   c. Do not use mason sand or sand conforming to ASTM C 144 for the bedding sand.
   d. Where concrete pavers are subject to vehicular traffic, utilize sands that are as hard as practically available.
   e. Sieve according to ASTM C 136.
   f. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 1.

Table 1
Grading Requirements for Bedding Sand
ASTM C 33

Sieve Size	Percent Passing
3/8 in.(9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075 mm)	0 to 1

2.4 EDGE RESTRAINTS

1. Provide edge restraints installed around the perimeter of all interlocking concrete paving unit areas as specified on contract drawings.

2.5 ACCESSORIES

1. Provide accessory materials as follows:
2. Sealers: 'Enhanced' stabilizing sealer by BP Pro Product or approved equal. BP Pro (714) 258-0800
3. Joint Sand. Polymeric Joint Sand by Logical Resource or approved equal. Logical Resource (760) 497-9690

PART 3 EXECUTION

3.1 ACCEPTABLE INSTALLERS

A. Only use ICPI certified installers.

3.2 EXAMINATION

A. Acceptance of Site Verification of Conditions:
   1. General Contractor shall inspect, accept and certify in writing to the paver installation subcontractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.
      a. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
      b. Verify that geotextiles have been placed according to drawings and specifications.
      c. Verify that aggregate and concrete base materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
      d. Provide written density test results for soil subgrade, aggregate base materials to the Representative, General Contractor and paver installation subcontractor.
      e. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.
   2. Do not proceed with installation of bedding sand and interlocking concrete pavers until subgrade soil and base conditions are corrected by the General Contractor or designated subcontractor.

3.3 PREPARATION

1. Verify base is dry, certified by General Contractor as meeting material, installation and grade specifications.
2. Verify that base is ready to support sand, edge restraints, and, pavers and imposed loads.
3. Edge Restraint Preparation:
   a. Install edge restraints per the drawings at the indicated elevations.

3.4 INSTALLATION

A. Spread bedding sand evenly over the base course and screed to a nominal 1 in. (25 mm) thickness, not exceeding 11/2 in. (40 mm) thickness. Spread bedding sand evenly over the base course and screed rails, using the rails and/or edge restraints to produce a nominal 1 in. (25 mm) thickness, allowing for specified variation in the base surface.
   a. Do not disturb screeded sand.
   b. Screeded area shall not substantially exceed that which is covered by pavers in one day.

B. Do not use bedding sand to fill depressions in the base surface.

C. Lay pavers in pattern(s) shown on drawings. Place units hand tight without using hammers. Make horizontal adjustments to placement of laid pavers with rubber hammers and pry bars as required.

D. Joint (bond) lines shall not deviate more than ±1/2 in. (±15 mm) over 50 ft. (15 m) from string lines.

E. Fill gaps at the edges of the paved area with cut pavers or edge units. No smaller than 1/3 its original size.

F. Cut pavers to be placed along the edge with a double blade paver splitter or masonry saw (Diamond Blade).

G. NO PAVERS SHALL BE CUT LESS THEN 1/3 ITS ORIGINAL SIZE. If need be adjust or slightly deviate from pattern to insure there are no small cuts. It may be possible to use a paver adhesive to glue smaller cuts to an adjacent paver making it a solid unit. However with glue there should still be no cut size less than 1/3.

H. All edges and borders shall be set in concrete. Note that a large underlayment of a concrete should have smaller paver cuts adhered to underplayed concrete borders.

I. Adjust bond pattern at pavement edges such that cutting of edge pavers is minimized. All cut pavers exposed to vehicular tires shall be no smaller than one-third of a whole paver.

J. Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and joint sand.

K. Use a low-amplitude plate compactor capable of at least minimum of 4,000 lbf (18 kN) at a frequency of 75 to 100 Hz to vibrate the pavers into the sand. Remove any cracked or damaged pavers and replace with new units.

L. Simultaneously spread, sweep and compact dry polymeric joint sand into joints continuously until full. This will require at least 4 to 6 passes with a plate compactor. Do not compact within 6 ft (2 m) of unrestrained edges of paving units.

M. All work within 6 ft. (2 m) of the laying face shall be left fully compacted with sand-filled joints at the end of each day or compacted upon acceptance of the work. Cover the laying face or any incomplete areas with plastic sheets overnight if not closed with cut and compacted pavers with joint sand to prevent exposed bedding sand from becoming saturated from rainfall.

N. Remove excess sand from surface when installation is complete. If Poly sand is used, Immediately sweep any excess joint sand from the surface in order to not have any sand stuck to the surface.

O. Surface shall be broom clean after removal of excess joint sand.

3.5 FIELD QUALITY CONTROL

A. The final surface tolerance from grade elevations shall not deviate more

B. than ± 3/8 in. (±10 mm) under a 10 ft (3 m) straightedge.

C. Check final surface elevations for conformance to drawings.

D. The surface elevation of pavers shall be 1/8 in. to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

E. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

3.6 CLEANING, SEALING, JOINT SAND STABILIZATION

A. Clean, Seal, Apply joint sand stabilization materials between concrete pavers in accordance with the manufacturer’s written recommendations.

3.7 PROTECTION

A. After work in this section is complete, the General Contractor shall be responsible for protecting work from damage due to subsequent construction activity on the site.

END OF SECTION

SECTION 328400
IRRIGATION SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Irrigation system consists of furnishing transportation, labor, materials, equipment and incidental services necessary to construct an irrigation system as shown on the Drawings and these Specifications Contractor's bid shall include all materials and services referenced in the Drawings and these Specifications, and shall be responsible for review and completion all these specification instructions herein.

B. Related Sections:

1. Section 129300 - Site Furnishings
2. Section 321400 - Unit Paving
3. Section 329000 - Planting
4. Section 329400 - Landscape Maintenance
5. Section 019113 - General Commissioning Requirements

1.2 REFERENCES

A. Comply with AB 1881 In particular the location of sprinklers, coverage and water use

B. American Society for Testing and Materials (ASTM):

1.	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
2.	ASTM D1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
3.	ASTM D1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4.	ASTM D2219	Standard Specification for Poly (Vinyl Chloride) Insulation for Wire and Cable, 60 Degrees C Operation.
5.	ASTM D2220	Standard Specification for Poly (vinyl chloride) Insulation for Wire and Cable 75 Degrees C Operation.
6.	ASTM D2241	Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure – Rated Pipe (SDR Service).
7.	ASTM D2464	Standard Specification for Threaded Poly (Vinyl Chloride) (PVC)Plastic Pipe Fittings, Schedule 80.
8.	ASTM D2466	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
9.	ASTM D2467	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe fittings, Schedule 80.
10.	ASTM D2468	Standard Specification for Acrylonitrile-Butaoliene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40.
11.	ASTM D2609	Standard Specification for Plastic Insert Fittings for Polyethylene(PE) Plastic Pipe.
12.	ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
13.	ASTM D2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

C. Local Plumbing Code

D. Uniform Plumbing Code

E. National Sanitation Foundation (NSF) Manual

F. Underwriters Laboratories (UL): Electrical wiring, controls, motors, and devices shall be U.L. listed, and so be labeled.

1.3 SUBMITTALS

A. Make submittals no later than 30 calendar days prior to start of work to which they apply.

B. Submit 6 complete lists of irrigation materials and equipment for approval by the Owner's Authorized Representative; include manufacturer's name and address, specific trade names, catalog numbers complete with illustrations and necessary descriptive literature and clearly mark or underline proposed items.
   1. Approval of an item, alternate, or substitute indicates only that the product or products appear to meet the requirements of Drawings and Specification on the basis of the information or samples submitted.
   2. Manufacturer's Directions: Where the manufacturer equipment is used in this Contract the manufacturer's Specifications and detailed Drawings shall be followed to provide installation methods not shown in the drawings and Specified herein.
   3. Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number and description of all materials and equipment to be used.
   4. Manufacturer's specifications, catalog cuts, and other data required demonstrating compliance with the specified requirements.
   5. Manufacturer's recommended installation procedures which, when approved by the Owner's Authorized Representative, will become the basis for accepting or rejecting actual installation procedures used on the job.
   6. Equipment or materials installed or furnished without prior approval of the Owner's Authorized Representative may be rejected and the Contractor required to remove and replace such materials from the site at the Contractor's own expense.
   7. Manufacturer's warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.

C. Disapprovals: Promptly resubmit for approval necessary data concerning a substitution for a disapproved item.

D. Procurement List: Use the approved list of irrigation materials and equipment for procurement without deviation unless otherwise authorized in writing by the Owner's Authorized Representative.

E. Record Drawings
   1. Provide and keep up-to-date Record Drawings, which shall be up-dated daily to show changes to the original Drawings and indicate the exact "as-built" locations of equipment. Prints for these purposes may be obtained from the Owner's Authorized Representative at cost. Record drawings shall be kept on the site at all times.
   2. Record Drawings shall serve as work progress sheets and shall be the basis for measurement and payment for work completed. Drawings shall be available at all times for review and shall be kept in a location designated by the Owner's Authorized Representative. Should the record black digital bond print drawing progress sheets not be available for review or not be up-to-date at the time of any review, it will be assumed no work has been completed and the Contractor will be assessed the cost of that site visit at the current billing rate of the Owner's Authorized Representative. No other reviews shall take place prior to payment of that assessment.
   3. The Contractor shall make neat and legible notations on the record drawing progress sheets daily, showing the work as actually installed.
   4. Before the final site review, transfer information from the "as-built" prints to procured from the Owner's Authorized Representative. Dimensions shall be made so as to be easily readable including the final controller chart. The original print "as-built" plan shall be submitted to the Owner's Authorized Representative for approval prior to the making of the controller chart.
   5. In addition to Record Drawing progress, dimension accurately from two (2) permanent points of reference (building corners, sidewalk, or road intersections), the location of the following items:
      a. Connection to existing water lines
      b. Connection to existing electrical power
      c. Gate valves
      d. Routing of sprinkler pressure lines (dimension) maximum 100'-0" along routing
      e. Remote Control Valves
      f. Routing of control wiring
      g. Quick coupling valves
      h. Controller
      i. Other related equipment as directed by the Owner's Authorized Representative
      j. Sleeve locations

6. Controller Charts
    a. The Owner's Authorized Representative shall review as-built drawings before controller charts are prepared.
    b. Provide three (3) 11 inches x 17 inches controller charts for each controller supplied.
    c. Show the areas controlled by the controller valve sequence. Make the chart a 11 inches x 17 inches reduced drawing of the actual "as-built" system. However, in the event the controller sequence is not legible when the drawing is reduced, enlarge it to a size that will be legible when reduced.
    d. The chart shall be a black digital bond print. A different color shall indicate the area of coverage for each station.
    e. When completed and approved, hermetically seal the chart between two pieces of plastic, each piece being a minimum of 10 mils.
    f. These charts shall be completed and approved within 10 days of final inspection of the irrigation system.
    g. The above-mentioned equipment shall be turned over to The Owner's Authorized Representative at the conclusion of the project.
7. Operations and Maintenance Manuals:
    a. Prepare and deliver to the Owner's Authorized Representative within 10 calendar days after completion of construction, 3 hard cover binders with 3 rings containing the following information:
        1) Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representatives.
        2) Catalog and parts sheets on every material and equipment installed under this Contract.
        3) Warranty statements on equipment.
        4) Complete operating and maintenance instructions on equipment furnished.
    b. In addition to the above-mentioned maintenance manuals, provide the Department's maintenance personnel, through the Owner's Authorized Representative, with instructions for major equipment.
    c. Provide the Department with a reduced legible copy of the "As-Built" Irrigation Plan hermetically sealed in a plastic cover to be affixed to the inside of each controller cover.
8. Equipment to be furnished:
    a. As part of this contract: upon completion of work for this section of the contract the contractor shall supply the following items to the Owner's Authorized Representative.
        1) 2 sets of special tools required for removing, disassembling, and adjusting each type of Spray Heads and Remote Control Valve supplied.
        2) Two, 5 foot valve keys for operation of shut-off valve.
        3) 2 keys for each for automatic controller and cabinet.
        4) Key and Hose Swivel for Quick Coupler (QC): For 1 thru 5 QC installed provide one (1) Key and Hose Swivel, 6 thru 10 = 2, 11 thru 15 = 3, 16 thru 20 = 4 and so on.
        5) Remote Control Valve (RCV): Minimum One (1) valve for every size used. Total valve per size and provide One (1) valve for the first 10 installed of each sizes, 11 thru 15 = 2, 16 thru 20 = 3, 21 thru 25 = 4, and so on.
        6) One (1) Hand-Held Radio Remote Transmitter for Controller.
        7) Spray / Rotator Sprinkler Body: Equal to two percent of amount installed for each type and size indicated, but no fewer than ten units.
        8) Spray / Rotator Sprinkler Nozzle: Two for each type and size installed for each type indicated.
        9) Bubblers: Equal to two percent of amount installed for each type and size indicated, but no fewer than ten units.
        10) Emitters: Equal to two percent of amount installed for each type and size indicated, but no fewer than ten units.

1.4 QUALITY ASSURANCE

A. Work force

1. Experience: The landscape establishment firm shall have a full time foreman assigned to the job for the duration of the contract. He shall have a minimum of four (4) years' experience in landscape establishment supervision shall be thoroughly familiar with the type of materials being installed and the manufacturer's recommended methods of installation and who shall direct all work performed under this section.
2. Labor force: The landscape establishment firm's labor force shall be thoroughly familiar and trained in the work to be accomplished and perform the task in a competent, efficient manner acceptable to the Owner's Authorized Representative.
3. Supervision: The foreman shall directly employ and supervise the work force at all times. Notify The Owner's Authorized Representative of all changes in supervision.
4. Identification: Provide proper identification at all times for landscape establishments firm's labor force. Be uniformly dressed in a manner satisfactory to the Owner's Authorized Representative.

B. Ordinances and Regulations: All local and state laws, rules and regulations governing or relating to any portion of this work are hereby incorporated into and made part of these Specifications. Nothing contained in these Specifications shall be construed to conflict with any of the aforementioned rules, regulations, or requirements. However, when these Specifications and Drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, then these Specifications shall take precedence.

C. Explanation of Drawings: Due to the scale of the drawings, it is not possible to indicate all offsets, fittings, and sleeves which may be required. The Contractor shall carefully investigate the structural and finished condition affecting the work and install a complete irrigation system within the intent of the Drawings and Specifications, furnishing such fittings and miscellaneous materials as may be required. Drawings are diagrammatic and indicative of work and materials required.

D. Discrepancies:
1. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is obvious upon field review that obstructions, grade differences or discrepancies in dimensions exist that might not have been considered in design. Differences shall be brought to the attention of the Owner's Authorized Representative. In the event this notification is not performed, the contractor shall assume full responsibility for any revision necessary.
2. Verify scaled dimensions and quantities prior to start of work.
3. Notify the Owner's Authorized Representative of discrepancies between Drawings and Specifications and actual job site conditions that would affect the execution of the irrigation work. Do not work in areas where discrepancies occur until instructed by the Owner's Authorized Representative in the event.

E. Permit and Fees: The Contractor shall obtain and pay for any and all permits and all inspections required by permits.

F. The new irrigation system tie-in shall meet all District standards as well as all the Owner's Authorized Standards and Design Criteria.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Exercise care in handling, loading, uploading and storage of pipes and fittings. Transport pipes in a vehicle allowing the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged will be discarded and, if installed, shall be replaced with new piping. Permission to store materials on site shall be obtained from the Owner.

1.6 INSPECTION

A. Notify the Owner's Authorized Representative 48 hours prior to time of the following required inspections:
1. Pressure supply line installation and testing.
2. Automatic controller and wire installation
3. .Lateral line and Sprinkler installation.
4. Coverage test.

B. Notify the District Representative 7 days prior to the time of final inspection.

1.7 PROJECT CONDITIONS

A. Existing Utilities and Plant Materials

1. Exercise care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by Contractor's operations or neglect. Check existing utilities drawings for existing utility locations. Contractor to verify all existing utilities through Dig Alert (800)-227-2600, two days before beginning construction.
2. Protect in place utilities and plant materials not designated for removal or modification against damage resulting from work of this Contract.
3. Repair or replace existing improvements not designated for removal, which are damaged or removed as a result of Contractor's operations. When a portion of a sprinkler system must be removed, the remaining lines shall be capped. Repairs and replacements shall be at least equal to existing improvements, and shall match them in finish and dimension.
4. Existing trees, lawns, and shrubbery that are not to be removed shall be protected from damage or injury. If damaged or removed because of the Contractor's operations, they shall be restored or replaced in as nearly the original condition and location as is reasonably possible.
5. Costs for protecting, removing, and restoring existing improvements shall be included in Contractor's Bid.

B. Verification of Dimensions and Quantities

1. Verify scaled dimensions and quantities prior to start of work.
2. Notify the Owner's Authorized Representative of discrepancies between Drawings and Specifications and actual job site conditions that would affect the execution of the irrigation work. Do not work in areas where discrepancies occur until instructed by the Owner's Authorized Representative.

C. Water And Power Service

1. Service connection points shall be as shown on Drawings unless otherwise directed by the utility company.
2. Contractor shall be responsible for installing 120-Volt electrical service and all labor and materials including connections.
3. Upon final acceptance of work, transfer billing to the Owner's Authorized Representative.

1.8 WARRANTY

A. Guarantee and Repairs

1. The Contractor shall warranty irrigation system installation for 2 years commencing at substantial completion in addition to the manufacturer's warranties.
2. The Contractor shall be responsible for coordinating material warranty items with manufacturer and distributor. The Contractor will be on call to replace or repair any faulty equipment or installation within 24 hours after notification by the Contracting Officer during the maintenance period.
3. The Owner's Authorized Representative reserves the right to make temporary repairs as necessary to keep the irrigation equipment in operating condition. The exercise of this right by the Owner's Authorized Representative will not relieve the Contractor of responsibilities under the terms of the guarantee.
4. Expenses due to vandalism during construction and the maintenance period shall be the responsibility of the Contractor. Maintenance period is as specified in section 02970 Landscape Maintenance.
5. A copy of the guarantee shall be in the operations and maintenance manual.
6. The Contractor shall be responsible for the irrigation system for two (2) years from the date of approval of Substantial Completion. The Contractor shall be responsible for the following tasks:
7. Replacement or repair of any broken or malfunctioning parts installed under this Contract, including heads, valves, and controllers.
8. Settling of backfilled trenches, which may occur during guaranty period, shall be repaired by Contractor at no expense to Contracting Officer, including complete restoration of finish grade treatment.

9. Guarantee Statement: Contractor to type on Contractor's letterhead the guarantee statement. The General Conditions and Supplementary Conditions of these Specifications shall be filed with the Owner's Authorized Representative prior to acceptance of the irrigation system.

B. Guarantee for Irrigation System

1. We hereby guarantee that the irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the Drawings and Specifications. We agree to repair or replace any defects in material or workmanship which may develop during the period of one year from date of acceptance, ordinary wear and tear, unusual abuse or neglect excepted, also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional costs to the Owner's Authorized. We shall make such repairs or replacements within a reasonable time, as determined by the Owner's Authorized, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner's Authorized, we authorize the Owner's Authorized to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PROJECT: _____

LOCATION: _____

SIGNED: _____

ADDRESSED: _____

PHONE: _____ DATE OF ACCEPTANCE: _____

1.9 SUBSTITUTIONS

A. Substitution of any product, material, or equipment without prior written approval of the Owner's Authorized Representative will not be permitted.

1. Approval of any item as a substitution or alternate shall be based on the following information, or, samples provided by the contractor:
   a. Provide a statement indicating the reason for making the substitution, using a separate sheet of paper for each item to be substituted.
   b. Provide descriptive catalog literature, performance charts, and flow charts for each item to be substituted.
   c. Provide the amount of cost savings if the substituted item is approved.
2. Be responsible for the total performance of such substitution to approved equal or surpass the original design in every respect.
3. If the substitution proved to be unsatisfactory in the opinion of the Owner's Authorized Representative, remove such work and install originally specified item.

1.10 MODIFICATION OF CONTRACT DRAWINGS

A. In each case where proposed substitute materials or equipment will require changes to the design of the project as indicated on Drawings, proposed revision drawings prepared by a licensed landscape architect, certified irrigation designer or engineer shall be furnished by the Contractor for installation of the proposed substitute materials or equipment and for construction by affected trades of the proposed revisions.

B. Cost of Drawings and of the proposed revised construction shall be borne by the Contractor.

1.11 INTENT OF DRAWINGS

A. Due to the scale of Drawings, it is not possible to indicate offsets, fittings, and sleeves, which may be required. Contractor shall investigate the finished conditions affecting the work and furnish fittings and other items, required to provide a complete irrigation system. Drawings schematically show the work to be installed

1.12 COORDINATION

A. Coordinate the irrigation installation with other sub-contractors including paving, utilities, site backfilling, landscape grading and landscape work.

PART 2 PRODUCTS

GENERAL

B. Irrigation plans have been prepared utilizing specific design standards, calculations, and criteria, including but not limited to the following: precipitation rates, flow rates, head spacing and coverage, flow rates, nozzle size and defined water window time frame. The Contractor shall be responsible for ensuring the installation of a complete and operating irrigation pump and irrigation system that meets or exceeds the design intent, standards, and parameters required by the plans and specifications.

C. The Contractor shall provide and install a complete and operating irrigation system, utilizing the same manufacturer and system parts as noted in the Drawings.

D. If all of the parameters, specifications and design intent of the Drawings are met, the following list of manufacturers with acceptable equipment model, series, size and designation, irrigation controllers; electrical connections; quick coupling valves; irrigation heads; drip and emitter irrigation piping and equipment) would be acceptable for use.

PIPE AND FITTINGS

E. Type of pipe material and fittings shall be in accordance with the following specification unless otherwise designated on Drawings:
   1. Plastic pipe shall be high impact rigid un-plasticized polyvinyl chloride PVC 1220 (Type 1, Grade 2), conforming to ASTM D1785, the minimum pressure rating to be not less than the working pressures indicated therein for the schedule and size listed. (PVC pipe marked with product standard PS-21-70 conforms to the ASTM requirements).
      a. Pipe to be homogeneous throughout and free from cracks, holes, foreign materials, blisters, deleterious wrinkles, and dents.
      b. Use Schedule 40 PVC plastic pipe for installation on the discharge side of control valves and Schedule 80 PVC plastic pipe for continuously pressurized pipe on the supply side of control valves, unless otherwise indicated.
      c. Use Schedule 80 PVC plastic pipe when threaded joints are specified.
      d. Continuously and permanently mark pipe with the following: Manufacturer's name or trademark, size, schedule, and type of pipe, working pressure at 73 degrees Fahrenheit and National Sanitation Foundation (N.S.F.) approval.
   2. Fittings and couplings for plastic pipe shall be threaded adapters with socket pipe for connections to threaded pipe. No Marlex riser and street ells shall be used for swing joint assembly. No galvanized fittings and riser shall be used.
   3. Pipe shall be identified with the following indelible markings:
      a. Manufacturer's name.
      b. Nominal pipe size.
      c. Schedule of class.
      d. Pressure rating.
      e. NSF (National Sanitation Foundation) seal of approval.
      f. Date of extrusion.

F. Solvent Weld Pipe shall be manufactured from virgin poly vinyl chloride (PVC) compound in accordance with ASTM D2241 and STM D1784; cell classification 12454-B, Type 1, Grade 1.
   1. Fittings shall be standard weight, Schedule 40, injection molded PVC; complying with ASTM D1784 and D2466, cell classification 12454-B. UV rated fittings required for above ground installation.
   2. Threads – injection molded type (where required).Tees and Ells – Side gated.
   3. Threaded nipples shall be Schedule 80 with molded threads, ASTM D2464.
   4. Primer and Solvent cement shall be of the type and make approved by the pipe manufacturer for use on its pipe. Unless noted otherwise by manufacturer, primer shall meet ASTM F-656, and cement shall meet ASTM D-2564. Weld-On by Christy's or approved equal.
   5. Fittings and couplings for plastic pipe shall be threaded adapters with socket pipe for connections to threaded pipe. Plastic pipe fittings and couplings shall be PVC I or PVC I/II material supplied in the same schedule and size specified for the pipe. Indicate the type of plastic material, schedule, and size on each fitting or coupling.

VALVES AND VALVE BOXES

G. General: Provide valves of the type and capacity designated herein and with the requirements specified. Valves shall be capable of satisfactory performance at a working pressure of 200 psi. Valve design shall permit disassembly for replacement of seals without removal of the valve body from the pipeline.

H. Shut-Off Valves: In sizes 2 inch and smaller shall be all bronze double disc wedge type gate valve with integral taper seats and non-rising stems. Sizes 2 1/2 inches and larger shall be iron body, brass trimmed with other features as per 2 inch size (per plan).

1. Use 10 inch diameter round valve boxes for shut-off valves.

I. Master Remote Control Valves shall be type and size as specified on the drawings.

1. Valves shall automatically close in event of electrical power failure or due to breakage of pilot wire.
2. Valve shall be normally closed 24 VAC solenoid actuated glove pattern, spring-loaded diaphragm type. The valve shall be pressure rated up to 200 psi at 150 degrees F.
3. Valve shall have a 60-pound test fabric reinforced rubber diaphragm assembly with self-cleaning stainless steel screen.
4. Solenoid shall be corrosion proof and constructed of stainless steel molded in epoxy to form one integral unit, 24-volt AC watt maximum holding milliamp in-rush, current: 0.41 amp (9.i VA, holding current: 023 amp (5.5 VA).
5. Valve shall have pressure reducing and surge protection.
6. Use rectangular valve boxes for Master remote control valves.

J. Remote Control Valve Assembly shall be type and size as specified on the drawings: Electrically operated, with accurately machined valve seat surface, equipped with flow control adjustment, with capability for manual operation and readily disassembled for servicing; slow opening and closing; and self-cleaning (per plan). Valve box lid to be heat branded with “RCV”

1. Solenoid shall be corrosion proof and constructed of stainless steel molded in epoxy to form one integral unit, 24 volt AC watt maximum holding milliamp in-rush, current: 0.41 amp (9.i VA, holding current: 023 amp (5.5 VA).
2. Drip Remote Control Valve Assembly including Ball Valve and Drip Filter and union. The assembly to be placed in a box separated from the remote control valve assembly as necessary.
3. Remote Control Valve Assembly including Ball Valve and Union.
4. Use a rectangle valve box.

K. Quick-Coupling Valves and Assemblies: Quick coupling valves shall be two piece type of the size as specified on the drawings, 150-psi working pressure. They shall be all brass and so constructed that they automatically close when the coupler is removed. All such valves shall be equipped with vinyl or rubber cover.

1. Quick coupler key is part of this assembly.
2. Quick coupler assembly shall have a pre-assembled double o-ring PVC swing joint with a viton o-ring sealed brass MIPT nipple factory molded into the outlet end. Inlet shall be PVC MIPT. Assembly shall be ¾ inch size, 12 inch lay length and equipped with both horizontal and vertical supports. Vertical support shall allow for insertion of rebar stabilizing rods to secure the quick coupler.
3. Use 10 inch diameter round valve box for quick coupler

L. Basket Strainers shall be type and size per drawings.

M. Rectangular Valve Boxes: shall be 15 inches wide by 21.5 inches long by 12 inches high constructed of rigid HDPE (high-density polyethylene) resin, chemically inert plastic with valve box extensions where required. Valve boxes shall be embossed with valve number. Manufactured by Carson Brooks or approved equal. Carson Brooks 1200 Jumbo Series.

N. Round Valve Boxes: shall be 10 inches in diameter constructed of rigid polyethylene, chemically inert plastic with valve box extension where required. Valve boxes embossed with valve number. Manufactured Carson Brooks or approved equal. Carson Brooks #910-10 with T-Cover #910-4B and Bolt-Down option.

O. Valve Box Covers: shall be green in color for use with potable water.

1. Valve box covers shall be locking plastic covers.
2. Heat Branding: shall be accomplished using branding irons specifically designed for this purpose. Heat branding shall not weaken or in any way puncture the valve box cover. Identification letters or numbers shall be 2-inches high. Identification shall be as indicated below or on the detail drawings.
    a. Remote Control valve box shall be rectangular. Heat brand box lid with the appropriate program and station number. Heat branded with the letters “RCV.”
    b. Quick Coupler valve box shall be round. Heat branded with the letters “QCV”
    c. Master Valve, box shall be rectangular, Heat branded with the letters “MV”
    d. Gate valve box shall be round. Heat branded with the letters “GV”
    e. Ball valve(BV) and pressure regulator (PR) and drip filter (DF).
    f. Air Relief Valve box shall be round. Heat branded valve box lid with “ARV”
    g. Flush Valve box shall be round. Valve box lid to be heat branded with “FV”
    h. Wire Splices box shall be rectangular. Heat brand with the letters “SB”
    i. Flow Sensor box shall be rectangular. Heat Brand lid with letters “FS”
    j. Traffic area valve boxes: Use precast concrete valve boxes with cast iron lid designed for vehicular traffic use.

ACCESSORIES

P. Gravel: All gravel used in valve boxes shall be washed crushed gravel of approximately ¾ inch size. No pea gravel shall be used.

Q. Identification Tags: yellow background with black lettering for potable water use, size 3”x4” by Christy’s or approved equal. Label tags as it is labeled on valve box cover lid, section 2.03, I.

R. Waterproof Wire Connectors shall be 3M Scotchlok™ 3570 Connector Sealing Packs insulate or approved equal and provide protection for electrical spring connectors. Each sealing pack contains a specific amount of Scotchcast™ 400 epoxy resin and will accommodate one Scotchlok™ Y, R, G, B, 3M Brand 212, 312 or 512 electrical spring connector. Scotchcast™ 400 electrical insulating resin is a two-part epoxy insulating and encapsulating resin. This resin, mixed in its unique container bag, generates its own heat to cure.

1. Resin must generates its own heat to cure, oil resistant, self-bonding, stable at elevated temperatures (up to 121°C). Include Unipak™ container bag for mixing the resin and encapsulating the appropriate spring connectors.
2.
3. The material must be Scotchcast™ 400 epoxy resin. It must be packaged in the 3M Unipak™ two-part polyethylene bag. The resin must be mixed within the Unipak™ container simply by separating the barrier between the two parts of the bag and between the two parts of the bag and the bag.

S. Control Wires: U.L. approved direct burial type U.F., 2-Wire cables shall containing two listed Sprinkler Systems Wires, single conductor, suitable for direct burial, for operation up to 600 volts, and temperatures up to 60ºC. Cable shall be manufactured by Paige Electric model number P7354D decoder cable direct burial 12 AWG solid copper with two conductors

1. The inner conductors shall be soft drawn bare copper meeting the requirements of ASTM specification B-3 or B-8. Insulation shall be low density high molecular weight polyethylene and a thickness of 0.045", per Paige Electric specification P7079D. The two conductors (blue and red) shall be twisted with a minimum lay of 4".
2. The overall jacket shall be High density polyethylene with a thickness of 0.035". Available with different color jackets. The jacket shall be sufficiently round, and loose, to facilitate its removal when being stripped. Minimum inner diameters of the outer jacket shall be 0.358 inches for 14 AWG/2c and 0.386 inched for 12 AWG/2c.
3. The surface of the inner conductors shall be printed “Paige Electric P7079D 14 AWG PE Listing file Number 600V Sprinkler System Direct Burial” and the surface of the outer jacket shall be printed “Paige Electric, P7354D, 14 or 12 AWG PE 600V Sprinkler System Wire Direct Burial.
4. Temperature rating of the cable -55ºC to +60ºC
5. Paige Electric recommends the strict use of Model DBR/Y-6, as manufactured by the 3M Company (Paige specification P7364D).

T. Detectable Underground Warning Tape: Consists of a minimum 4.5 mil (.0045") overall thickness by 3" wide with a solid aluminum foil core. The imprinted warning message is "Caution Buried Irrigation Line Below" to prevent ink rub-off, and is impervious to acids, alkalis and other destructive elements found in the soil. The imprint is as such that it allows for total reflectivity. A tape must be visibly seen before it can be read. APWA Color coded

CONTROLLER UNIT

U. Controller(s)shall be Calsense CS3000 controller, and shall be installed per manufacturer's specifications, as shown on the drawings, and as specified herein.

V. The irrigation system controller shall be capable of fully automatic, semi-automatic, test and manual operation. The stainless steel enclosure controller enclosure shall be per Section 2.08.

W. The controller shall operate on a input of 120 VAC, 60 Hz, 1.0A and a 40VA transformer with output of class 2, rated 24 VAC, maximum total load 1.5A and be capable of actuating up to five .25A solenoids plus a master valve or pump start relay. The controller shall operate three stations plus the master valve simultaneously.

X. The controller shall have a backlit 16 line by 40 character display where information can be viewed at once without scrolling through menus including an area description for each station 40 characters long such as where it is located, the type of plant material irrigated, and type of equipment used.

Y. The controller shall have 7 regular irrigation programs plus two syringe/propagation program, with individual station Cycle & Soak watering,

Z. The controller shall have a water budget feature that provides monthly water volume budgets proportionate to historical ET and interactive with all programs, and able to alert user when controller's water usage is more than a user set water budget.

AA. The controller shall have programming based on a 7,14, 21 or 28 day scheduling and be able to irrigate in minutes, inches, percent of ETo and/or soil moisture content.

BB. The controller shall have the capability to have a full year master schedule to allow 12 month programming.

CC. The controller shall have the ability to display area, plant and/or equipment descriptions for each station.

DD. The controller shall be capable of programming all or a group of stations with the same run time and soak-in time by using a Copy key.

EE. The controller shall be capable of operating a test program without affecting the controller's normal program station times or without terminating a regular watering schedule.

FF. There shall be complete English and Spanish operator's manual built in the controller and viewed in the controller's display.

GG. The controller shall have internal non-volatile memory capable of lifetime program memory retention without the use of batteries.

HH. The controller shall be capable of reading a flow sensor and automatically "learn" each station's average GPM flow rate on a continuous basis.

II. There shall be a built-in amperage meter to accurately measure display and diagnose valve solenoid electrical problems such as 'No Current', 'Station Short', 'Under Current', 'Over Current', etc.

JJ. The controller operating as a satellite shall be capable of irrigating the program entered by the central (base computer) or by programming at the satellite location, without having to go back to the central to accept the change. The controller shall allow individual station operation of any field satellite units. Controller shall also be capable to remotely perform all satellite keystroke operation from the central (base computer) utilizing an on-screen graphics replica of the satellite controller panel.

KK. The controller shall be able to log for each station for the last 30 watering days the following information:

1. Time and date irrigation ran
2. Number of repeat cycles run
3. Programmed minutes and actual minutes run
4. Programmed inches and actual inches applied
5. Manual & Test minutes
6. No Water days programmed
7. Hold-Over Time
8. Actual GPM flow rate that night compared to Learned or Limit value
9. Alert Flags

LL. The controller shall have an operator-set water window. Irrigation will not continue past a set end time. Remaining run-times will be carried over in a hold-over table to be applied at next scheduled irrigation and the system will prioritize which valve to operate based on this held-over time.

MM. Multi-level Access protection settable using central software. Controller will log when user signed in and when user signed out. This allows the user to create management of the system any way he or she chooses.

NN. Optional Radio Remote receiver board shall be built-in the controller and a hand-held radio remote transmitter will be supplied as specified on Drawings so that the end user can trouble shoot valves remotely without having to go the controller itself. The Remote Sensor shall have the ability to display information in the handheld including flow rate and electrical draw of the operating outputs. Editable station information available to view and edit at the handheld include total minutes, minutes per cycle, soak in time, expected flow rate, and square footage. The keypad shall be user-friendly and provide for immediate intuitive operation.

OO. Controller shall have a detailed water usage report categorizing for each month the usage during scheduled irrigation, during test and manual key operation, and when valves are bled manually or quick couplers are used.

PP. The controller shall have manual functions that include test and manual for individual as well as groups of valves, two separate syringe, manual programs with six start times each, as well as a Walk Thru Program that allows a programmed delay time to get to a certain area and then manual water a sequence of predetermined stations for set program times.

QQ. The controller shall communicate with other controllers in line-of-sight proximity using spread-spectrum radios, providing a reliable communication link instead of a hardwire communication path when sharing data. The spread-spectrum radio option(-SR) does not require FCC licensing, and offers a secure error correcting frequency hopping radio link immune to outside interference. A single controller model number shall be –SR, while multiple controllers sharing a single spread-spectrum radio shall be designated as a –SR-M and –M configuration.

CONTROLLER ENCLOSURE(S)

RR. The enclosure shall be of a vandal and weather resistant nature manufactured entirely of 304-grade stainless steel, top 12 gauge and the body 14 gauge. The main housing shall be louvered upper and lower body to allow for cross flow ventilation. A stainless steel backboard shall be provided for the purpose of mounting electronic and various other types of equipment. The backboard shall be mounted on four stainless steel bolts that will allow for removal of the backboard.

SS. The 38-inch height with flip top shall provide easy access for easy programming from a standing position under normal installations.

TT. The pre-assembled vandal resistant enclosure shall come complete with lightning and surge protection. All terminals shall be factory labeled. On/Off switch provided to isolate controller along with GFI receptacle. Radio antenna shall be pre-mounted and connected on SSE-R enclosure for radio remote capability. Enclosure includes 2-7/8 inch 1-1/2 inch thick, 6-pin cylinder, die-cast steel padlock with unique shackles design.

UU. Factory pre-assembled enclosure with controller shall carry full UL listing.

VV. Factory pre-assembled enclosure with controller shall carry a 10-year limited warranty.

WW. Enclosure shall be mounted on a poured-in-place concrete pad.

ELECTRICAL

XX. Supply line voltage conductors with THW/THWN, 600-volt insulation rating, per ASTM D2219 and D2220.

YY. Rigid electrical conduit shall be Schedule 40 galvanized steel, threaded and bushed with packing placed in the ends to protect the wiring. Sweep ends of conduit into pull boxes to make splices.

FLOW MONITORING SENSOR

ZZ. Flow Meter and cable shall be type and size as specified on Drawings, one red wire, and one black wire in 1-1/4" PVC conduit to connect to the irrigation controller. The maximum wire run between flow meter and controller shall be 2000 ft. The flow meter sends low voltage digital pulses back to the controller and therefore all electrical connections must be waterproof and resist any moisture entry.

AAA. It is intended that all wire runs between the controller and flow meter be direct pulls and have no splices. If wire splices are unavoidable, they must be installed in a valve box with 3M Scotchlok 3570 connectors or approved equal.

BBB. Each flow meter shall have the following characteristics:

1. Housing to be a Sch 80 polyvinyl chloride tee or bronze tee
2. Have a pulsing output that operates at 9 VDC and a pulse rate that is proportionate to the GPM
3. Fully compatible with the internal interface at each field controller
4. Powered by the controller
5. Replaceable metering insert
6. Shall feature a six-bladed design with a proprietary, non-magnetic sensing mechanism
7. Be by the same manufacturer as the irrigation controller.

CCC. Single controller shall be able to receive up to three separate flow meter inputs on projects consisting of more than one water source for irrigating landscape. The controller shall sum up the readings of all flow sensors connected.

SPRINKLER EQUIPMENT

DDD. Sprinklers, rotors, bubbler heads, and spray nozzles shall be of the types and sizes shown on Drawings, with plastic nozzles unless otherwise indicated.

EEE. Nozzles: Provide equipment of one type and flow characteristic from the same manufacturer and bearing the manufacturer's name and identification code in a position where they can be identified in the installed position.

FFF. Provide fixed head sprinklers with a one piece housing and with provisions for interior parts replacement. Pop-up sprinklers to rise 12 inches in shrub areas, 6 inches in turf areas. Sprinklers on fixed riser to be at least 12 inches above grade and 2 inch for fixed bubblers.

GGG. Inline anti drain check valve shall be used to prevent low head drainage. Hunter HCV anti drain valve or approved equal.

LOW FLOW WATERING SYSTEM

HHH. Refer to irrigation plans and legends for low flow watering system.

PART 3 EXECUTION

IRRIGATION SYSTEM INSTALLATION

III. General:

1. Notify Owner's Authorized Representative in writing at least 48 hours before testing will be conducted Conduct tested in presence of the Owner's Authorized representative.
2. Perform work on the irrigation system, including hydrostatic and coverage tests, preliminary operational test of the automatic control system, and the backfill and densification of trenches and other excavations after topsoil work and before planting.
3. Prior to installation, stake out pressure supply line routing and locations of spray heads, tree bubblers, Low flow irrigation system lines.

4. Plant large specimen plants (24 inch box or larger) before installing the irrigation system; reroute irrigation lines conflicting with specimen plant locations to clear the root ball.
5. With the Owner's Authorized Representative's approval, make adjustments where necessary to conform to actual field conditions unless otherwise noted. Irrigation system layouts shown on Drawings shall be considered schematic or diagrammatic.
6. Make the irrigation system operational with uniform coverage of the areas to be irrigated, prior to planting.
7. Piping on Drawings shown in paved areas running parallel or adjacent to planted areas, are intended for design clarification only and shall be installed in the planted area whenever possible.
8. Make water and utility connections as shown on Drawings or as approved by the Owner's Authorized Representative. If utility connections are not shown on Drawings, Contractor shall estimate 100 feet to each service point. Replace sidewalks, curbs, or paving removed by the installation of the water and electrical meters and service.

TRENCH EXCAVATING AND BACKFILLING

JJJ. Size trenches and other excavations to accommodate the irrigation system components, conduits, and other required facilities. Provide additional space to assure proper installation and access for inspections.

1. Trenching for irrigation system shall be done after completion of soil conditioning and finish grading operations.
2. Unless otherwise specified, the minimum depth of cover over pipelines and conduits shall be as follows:
   a. Electrical conduit: 24 inches (36 inches under roadways, driveways, and parking lots).
   b. Waterlines continuously pressurized: 18 inches (24 inches under roadways, driveways and parking lots).
   c. Lateral sprinkler lines: 12 inches. (18 inches under roadway and parking lots)
3. Make the bottom of trenches true to grade and free of protruding stones, roots, or other matter which would prevent bedding of pipe or other facilities.

KKK. Trenches shall not be backfilled until required tests are performed.

1. Backfill trenches so that the specified thickness and density of the topsoil is restored throughout the entire depth of the trench.
2. Backfill may be flood compacted in landscaped areas to a dry density equal to adjacent soil in planting areas. Backfill shall join flush to adjacent grades without dips, sunken areas, humps or other surface irregularities.
3. Mechanical compacted backfill shall be by means of hand-directed mechanical tampers in 4 inch lifts or roller equipment including sheeps foot, grid, smooth wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheel in maximum 12 inch lifts.

LLL. Compact trench backfill through paved areas in 8 inch layers to 90 percent relative compaction up to sub grade to receive paving and base material.

1. Resurface trenches through paved areas to match existing pavement.

MMM. If settlement occurs and subsequent adjustments of pipes, valves, irrigation heads, planting areas, or other construction are necessary, Contractor shall make required adjustments without additional cost to the Owner.

IRRIGATION PIPELINE INSTALLATION

NNN. General: Execute trench excavating and backfilling, including the depth of cover over the pipeline.

1. Install pipe fittings in accordance with the manufacturer's written recommendations and Reference Specifications. Furnish the Owner's Authorized Representative with the manufacturer's printed installation instructions which deviate from specifications, for approval before pipe installation.
2. Bed pipe in at least 2 inches of finely divided soil to provide a firm, uniform bearing. Surround the pipe with additional finely divided soil to at least 2 inches over the top of the pipe.
3. Deposit trench backfill to anchor the pipe before the pipeline pressure testing, except that joints shall remain exposed until satisfactory completion of testing.

4. When 2 or more pipelines are installed in the same trench, separate the pipelines by a minimum horizontal clear distance of 4 inches. Install them so that each pipeline, valve, or other pipeline component may be serviced or replaced without disturbing the other.
5. Make assemblies as specified and in accordance with the manufacturer's directions or as detailed on Drawings.
6. During installation of pipe, fittings, valves, and other pipeline components, prevent foreign matter from entering the system. Temporarily cap or plug open ends at cessation of installation operations.
7. Make changes in pipeline size with reducer fittings. Do not use close nipples or bushings.
8. Place mainlines under paving in Schedule 40 PVC sleeves. Oversize the sleeves 2x to house the pipe, fittings, and control wires.
9. Separate dissimilar metals by an approved "Dielectric" coupling.

OOO. Plastic Pipeline:

1. Join plastic pipe with socket type solvent welded fittings, threaded fitting, rubber ring fittings or by other means specified. Install steel pipe first when plastic pipe is joined to steel pipe.
2. Cut pipe using a pipe cutter, do not use a saw. Cut square, externally chamfer approximately 10 to 15 degrees and remove burrs and fins.
3. On PVC to metal connections, work the metal connections first. Teflon tape or approved equal, shall be used on all threaded PVC to PVC, and on all threaded PVC to metal joints.
4. Make solvent welded joints in accordance with ASTM D2855. Use the primer and solvent recommended by the pipe manufacturer. Do not use solvent with threaded joints.
5. Install plastic pipe in accordance with ASTM D2774 and the requirements herein.
6. Exercise care in assembling pipeline with solvent welded joints so that stress on previously made joints is avoided. Handling of the pipe following jointing, such as lowering the assembled pipeline into the trench, shall not occur prior to the set times specified in ASTM D2855.
7. Apply primer and solvent to pipe ends so that no material is deposited on the interior surface of the pipe or extruded into the interior of the pipe during jointing. Wipe off excess cement on the exterior of the joint immediately after assembly. Install No multiple assemblies in plastic lines. Provide each assembly with its own outlet.
8. Protect pipe from tool damage during assembly. Use vises with padded jaws and strap wrenches for installation of fittings and nipples.
9. Remove and replace plastic pipe which has been nicked, scarred, or otherwise damaged.
10. Snake plastic pipe from side to side in the trench to allow 1 foot of expansion and contraction per 100 feet of straight run.
11. Do not expose the pipeline to water for 24 hours after the last solvent welded joint is made.

INSTALLATION OF VALVES, VALVE BOXES, AND SPECIAL EQUIPMENT

PPP. Install valves and equipment in accordance with the details in a normal upright position, unless otherwise recommended by the manufacturer, and make readily accessible for operation, maintenance, and replacement.

QQQ. Install valves of the same size as the pipeline in which they are installed, unless otherwise indicated on Drawings.

RRR. Install shut-off valves and sectional automatic control valves using brass or bronze unions with copper or brass seats, below ground.

SSS. Install quick-coupler valves and hose bibs projecting above grade 1 foot from curbs, pavement, and walks when possible.

TTT. Set valve boxes to finish grade on a minimum 12 inch deep layer of gravel and set valves at depth to provide clearance between the cover and valve handle or key when the valve is in the fully open position. Do not cover valve with gravel.

UUU. Install a line sized shut-off valve on the pressure side of all sectional remote control valve.

VVV. Install a line size shut–off valve in a 10 inch diameter valve box on the up-stream side of main lines crossing streets.

REPAIR/RESTORATION

WWW.The Owner's Authorized Representative reserves the right to make temporary repairs as necessary to keep the irrigation system equipment in operating condition. The exercise of this right by The Owner's Authorized Representative shall not relieve the Contractor of his responsibilities under the terms of the guarantee as herein specified.

IRRIGATION HEAD INSTALLATION AND ADJUSTMENT

XXX.Flush and pressure test mains and laterals, and risers before installing irrigation heads, Low Flow Irrigation System and Tree Bubblers and before performing water coverage test to the complete satisfaction of the Owner's Authorized representative.

YYY.Location, Elevation and Spacing:

1. Install the spray heads in accordance with Drawings.
2. Spacing of spray heads shall be installed for head to head coverage. In no case shall the spacing exceed the maximum recommended by the manufacturer.
3. Install irrigation heads adjacent to curbs, walks, paving, and similar improvements on pop-up spray bodies with tops set flush to finished grade.

ZZZ.Riser installation:

1. Install riser perpendicular to finished grade to obtain optimum coverage of the area.
2. Provide threaded pipe between the connection to the lateral or main and the sprinkler head.
3. Riser assemblies shall be triple swing joint type with Schedule 80 PVC nipples and threaded fittings.
4. Install check valves to prevent low head drainage.

AAAA.Irrigation Head Adjustment:

1. When irrigation heads are installed and the irrigation system is operating, adjust and balance each section or unit with section control valves fully open to obtain uniform and adequate coverage.
2. Flush and adjust all Sprinkler Heads, Tree Bubbler and Low Flow Irrigation for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make such adjustments prior to planting. Adjustments may also include changes in nozzle sizes and degrees of arc as required.
3. At no time shall the irrigation system to spray water on pavement and structures.

BBBB.Low Flow Irrigation System Installation

1. All emitters and heads shall be set perpendicular to the finish grade.
2. Low Flow Irrigation lateral lines shall be buried 8 inches below grade.
3. Contractor shall flush out all lines prior to backfill and adjust valves for optimum coverage.
4. To flush single emitter with flush stem, flush cap must be unscrewed before flushing can begin and must be completely retightened after completion of each system flush.
5. Emitter tube in planter areas to remain 2 inches above finish surface.
6. All trenches to be backfilled, leveled, and compacted to the same relative compaction as the natural soil. No settling of trenches will be acceptable

CONTROLLER SYSTEM INSTALLATION

CCCC.Install controller per manufacturer's instructions. Contractor shall have 5 years of experience installing Calsense Controllers. Remote control valves shall be connected to controller in numerical sequence as shown on the drawings.

DDDD.Control system to be certified by Calsense. Submit certification to the Owner's Authorized Representatives. Contact Mark Huntzinger at Calsense at 760-580-1827. Certification shall state the Controller is connected and is sending and receiving information from all necessary irrigation equipment especially the Flow Sensor and Master Valve.

EEEE.Install a complete automatic irrigation control system, including the 120 Volt electrical service, automatic controller, automatic control valves and wiring, and necessary accessories and utility service connections as required by the controller manufacturer.

FFFF.Install the automatic controller outside of the coverage pattern of the irrigation system at the location designated on Drawings or as directed by the Owner's Authorized Representative in accordance with the details.

GGGG.Install a separate disconnect switch between the source of power and the controller. Fuse control components in the controller and ground the chassis.

HHHH.Install service wiring at a minimum depth specified, in galvanized steel electrical conduit from the service point to the controller. The minimum service wire shall be No. 12 AWG copper 600 volt type THW/THWN insulation, or as required by the controller manufacturer. Locate splices only in specified pull boxes and make splices with a waterproof packaged kit approved for underground use. Set top of pull boxes flush to finish grade on a 12 inch deep layer of ¾ inch gravel.

IIII. House control wiring in a conduit between the controller and an electrical pull box at the base of the controller. House control wire under paved areas in a Schedule 40 PVC pipe sleeve. Other wiring issuing from the electrical pull box shall be direct burial, installed in the main or lateral waterline trenches wherever practicable.

JJJJ.Color code common wire white with control wire any color except white. Make splices in control wire with approved waterproof connectors in accordance with the requirements for service wire. Leave at least 2 feet of coiled slack at each splice and point of connection inside the valve boxes.

KKKK.Test wiring for continuity, open circuits, and unintentional grounding prior to connection to equipment.

LLLL.Leave the control system in operating condition with an operational chart mounted within the controller cabinet upon completion of the work.

FLUSHING AND TESTING

MMMM.Flushing: After completion, and prior to the installation of terminal fittings, flush the entire pipeline system through strainer until there is no longer any evidence of debris. After flushing, conduct the following tests in the sequence listed below. Provide equipment, materials, and labor necessary to perform the tests. Conduct tests in the presence of the Owner's Authorized Representative.

1. Pipeline Pressure Test: Perform a water pressure test on pressure mains before couplings, fittings, valves, and the likes are concealed. Cap open ends after the water is turned on to the line so that the air will be expelled. Test pressure mains with control valves to lateral lines closed. The constant test pressure and the duration of the test are as follows:
2. Pressure line (Mainline): 4 hours at 150 psi.
3. Spray Coverage Test: Perform the coverage test in the presence of a Owner's Authorized Representative after sprinkler heads have been installed and before groundcover has been planted, to demonstrate that each section or unit in the irrigation system is complete and balanced to provide uniform and adequate coverage of the areas serviced. Correct deficiencies in the system.
4. Operational Test: Evaluate the performance of components of the automatic control system for manual and automatic operation. During the maintenance period, and at least 15 days prior to final inspection, set the controller on automatic operation so that the system will operate during such period. Make repairs, replacements, and adjustments until equipment, electrical work, controls, and instrumentation are functioning as specified.

FINAL INSPECTION PRIOR TO ACCEPTANCE

NNNN.Operational Test:

1. Evaluate the performance of components of the Automatic Control System for manual and automatic operation. During the maintenance period, and at least 15 days prior to final inspection, set the Controller on automatic operation so that the system will operate during such period. Make repairs, replacements, and adjustments until equipment, electrical work, controls, and instrumentation are functioning as specified.

OOOO.Inspection for final acceptance of the irrigation system shall occur together with inspection for final acceptance of plantings at end of the Plant Establishment Period as specified in PLANTING Section.

PPPP.Contractor shall operate each system with hand held remote control for the Owner's Authorized Representative at time of final inspection. Items deemed not acceptable by the Owner's Authorized Representative shall be reworked to the satisfaction of the Owner's Authorized Representative.

QQQQ.Contractor shall show evidence to the Owner's Authorized Representative that the Owner has received accessories, charts, record drawings, and equipment as required before final inspection can occur.

RRRR.Contractor shall make available hand held remote control for all field inspection.

CLEANUP

SSSS.Cleanup shall be made as each portion of work progresses. Remove refuse and excess dirt from the site. Walks and paving shall be broom swept or washed down daily, and damage done on the work of others shall be repaired to the satisfaction of the Owner's Authorized Representative.

END OF SECTION

SECTION 329000
PLANTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnish all labor, material, equipment and services necessary to provide all landscape planting, complete in place, as shown and specified herein, including soil preparation, planting, seeding, staking and clean-up.
   2. Any plant deemed 'Not Available' shall be noted in the bid. Failure to qualify availability of specified material shall make the Contractor responsible for all supplying of all material. Maintenance period may not begin until specified materials are installed.

B. Related Sections:
   1. Section 129300 - Site Furnishings
   2. Section 321400 - Unit Paving
   3. Section 328400 - Irrigation Systems
   4. Section 329400 - Landscape Maintenance

C. Reference Standards:
   1. American Society for Testing and Materials (ASTM International):
      a. ASTM A36 Standard Specification for Carbon Structural Steel
      b. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
      c. ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
      d. ASTM D2434 Standard Test Method for Permeability of Granular Soils (Constant Head)
   2. Council of Tree and Landscape Appraisers:
      a. Manual for Plant Appraisers Handbook, Guide for Establishing Values of Trees and Other Plants.
   3. State of California Agricultural Code
   4. Sunset Western Garden Book
      a. Sunset Publishing Corporation, 2012 Edition
   5. U.S.A. Standards for Nursery Stocks
      a. American Nursery & Landscape Association, ANSI Z60.1-2014

1.2 SUBMITTALS

A. Certification: From a qualified arborist that the tree indicated to remain have been protected during construction according to recognized standards and that tree is promptly and properly treated and repaired when damaged.

B. Submittals for review during construction phase:
   1. Manufacturer's or vendor's certified analysis for all herbicides, fertilizers, soil amendments, staking and guying materials.
   2. The Owner’s Authorized Representative reserves the right to take and analyze samples of materials for compliance at any time. Furnish samples upon request by The Owner’s Authorized Representative. Rejected materials shall be immediately removed from the site at the Contractor's expense. Cost of testing of materials not meeting these specifications shall be paid by The Contractor, except for any imported top soil which will include testing as part of any additional cost.

3. Submit documentation to the Owner's Authorized Representative within forty-five (45) calendar days after date of Owner approval of final plans that all plant material is available. The Contractor shall be responsible for all material listed on plant list. Any and all substitutions due to availability shall be requested in writing prior to confirmation of ordering. All materials shall be subject to observation by the Owner's Authorized Representative at any time after confirmation of ordering. The list should also be submitted to Wallace Laboratories to confirm plant/soil compatibility.
4. Submit proposed planting schedule indicating anticipated dates for each type of landscape work. Once accepted, revise schedule only as approved in writing.
5. Submit 4" x 7" (or larger) color photos of all plant materials to be installed on the project site as noted on the Contract Documents.
6. Plants shall be subject to observation and preliminary acceptance by the Owner's Authorized Representative at place of growth or upon delivery for compliance with these specifications.
    a. Submit written request for observation of plant material 24" box size or larger at place of growth to The Owner's Authorized Representative. Written request shall state the place of growth and quantity of plants to be observed. The Owner's Authorized Representative reserves the right to refuse observation at this time if, in his judgment, a sufficient quantity of plants is not available for review.
    b. Such observation shall not impair the right of observation and rejection during progress of the work.
    c. Tagging of plant material by The Owner's Authorized Representative is for design intent only and does not constitute the Owner's Authorized Representative's approval of the plant materials in regards to their health and vigor.
    d. The health and vigor of the plant materials is the sole responsibility of the Contractor.
7. Submit specifications of any item being used on site upon the request of the Owner's Authorized Representative.

C. Certifications:

1. Submit a certificate if requested by The Owner's Authorized Representative of delivery slip with each delivery of material in containers or in bulk. Certificates shall state source, quantity, or weight, type and analysis and date of delivery. Materials which are not pre-packaged shall have analysis completed by Wallace Laboratories (310) 615-0116 or approved equal (see plans). Deliver all certificates to The Owner's Authorized Representative s prior to installation, incorporation or application of the material.
    a. Quantities of fertilizer.
    b. Quantities of soil amendments

1.3 QUALITY ASSURANCE

A. Installer Qualifications:

1. Experience: The landscape establishment firm shall provide at least one English-speaking person full time assigned to the job for the duration of the contract. He shall have a minimum of four (4) year experience in landscape establishment supervision, with experience or training in tree maintenance, entomology, pest control, soils, fertilizers, and plant identification.
2. Supervision: The foreman shall directly employ and supervise the work force at all times. Notify the District Representative of all changes in supervision.
3. Labor Force: The landscape establishment firm's labor force shall be thoroughly familiar and trained in the work to accomplished and perform the task in a competent, efficient manner acceptable to the District Representative.
4. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.
5. Installer Qualifications: Company specializing in installing and planting the plants with six year experience.
6. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.
7. Tree Pruning: NAA - Pruning Standards for Shade Trees to be followed.
8. Maintenance Services: To be performed by the landscape installer.
9. Identification: Provide proper identification at all times for landscape establishments firm's labor force.
    a. Be uniformly dressed in a manner satisfactory to the Owner's Authorized Representative.

B. Materials and Workmanship:

1. Observations:
   a. In all cases where observations are required, notify the Owner's Authorized Representative at least four working days in advance of the time of observation.
   b. The Contractor shall schedule and make available the information and materials indicated for review by the Owner as listed herein after. Observation by the Owner's Authorized Representative shall not relieve the Contractor of completing the work in conformance to the Contractor Documents
   c. Observation of site at critical stages of work.
   d. Observation for approval of landscape finish grading and soil preparation before installation of plant material:
      1) During this observation the Owner's Authorized Representative may request that samples of the prepared soil be analyzed by an approved laboratory to assure its compliance with these Specifications.
      2) Notification of exception shall be to correct deficiencies in the soil preparation to render it in compliance with these specifications. Corrections shall be made prior to any planting; the installation of container sized plants may proceed if the corrections can be made later without affecting the quality of the work. Notify the Owner's Authorized Representative in writing when the deficiencies have been corrected.
         (a) Observation of planting installation.
         (b) Observation of tree staking.
   e. Observation by the Owner's Authorized Representative will be made at substantial completion of all materials, construction and installation work required by the Contract Documents prior to commencement of the plant establishment period. The plant maintenance period shall not commence until all deficiencies found by this observation have been corrected and written notice of start of commencement has been received from the Owner's Authorized Representative. All materials shall be installed prior to this observation with the following exceptions:
      1) Items waived by the Owner's Authorized Representative for this observation for reasons of substantiated unavailability, or in appropriate season or weather.
      2) Items which do not affect the health or growth of the plantings.
   f. Periodic observation shall be made of the work of the Contract Documents during plant establishment period.
2. Materials:
   a. Specimen and 24" box size or larger plant materials shall be observed at source prior to delivery to site.
   b. Upon delivery of plant material to site:
   c. All plant material shall be observed and approved by the Owner's Authorized Representative for quality, size and variety prior to installation. Such approval shall not impair the right of observation and rejection during the progress of work for size and condition of ball or root mass, latent defects, diseases, pests or injuries.
   d. A maximum of two observations for approval of plant material will be made by The Owner. For the first observation, present not less than 50% of the total of required plant material. Submit the remainder at the second observation.
   e. If any defective or non-complying plants are found during observations, they will be rejected.
   f. All rejected plant material shall be removed from the site within a minimum of two working days.
   g. Site Soil Quality:
      Contractor shall provide preliminary site soils test to determine suitability of existing soil with plant material requested by the Owner's Authorized Representative.
      If import soil is required, the Owner's Authorized Representative or the Contractor shall identify a source for top soil that will be tested by the following lab as an additional cost to the project.
      Take one (1) representative soil sample from area identified in the Drawings. Submit with a site map showing locations to Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245 (310) 615-0116 or approved equal.

Soil samples shall be tested for pH, alkalinity, total soluble salts, porosity, extractable sodium content, magnesium, boron, chloride, SAR, nitrate, phosphorus, potassium, organic matter, and soil preparation recommendations.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
   1. Deliver fertilizer to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark, and compliance with all applicable laws.
   2. Deliver all plant blocks with legible identification labels.
   3. State correct plant name and size indicated on plant list.
   4. Use durable waterproof labels with water-resistant ink, which will remain legible for at least 60 calendar days.
   5. Protect plant materials during delivery to prevent damage.
   6. The Contractor shall notify the District Representative 4 calendar days in advance of delivery of all plant materials and shall submit an itemized list of the plants in each delivery.
   7. Storage:
      a. Store plant material in shade and protect from weather.
      b. Maintain and protect plant material in healthy, vigorous condition.

B. Handling: The Contractor shall exercise care in handling, loading, unloading and storing of plant materials. Plant materials that have been damaged in any way shall be discarded and if installed, shall be replaced with undamaged materials at the Contractor's expense.

1.5 PROJECT CONDITIONS

A. Existing Utilities:
   1. Exercise care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities which are caused by Contractor’s operations or neglect. Check existing utility drawings for existing utility locations. Contractor to verify all existing utilities through Dig Alert, at (800) 227-2600 a minimum of 2 days prior to construction.
   2. Repair or replace existing improvements which are not designated for removal which are damaged or removed as a result of Contractor’s operations. When a portion of a sprinkler system must be removed, cap the remaining lines. Repairs and replacements shall be equal to existing improvements, and shall match them in finish and dimension.
   3. Protect existing utilities that are not to be removed from damage or injury. If damaged or removed because of the Contractor's operations, they shall be restored or replaced in, as nearly the original condition and location as is reasonably possible.

B. Perform actual planting only when weather and soil conditions are suitable and will not be detrimental to the plant material.

1.6 WARRANTY AND GUARANTIES

A. For Protected Trees during the warranty period: the Contractor shall be liable for damages to all protected trees covered by the provisions of this Section and shall pay compensation to Owner’s Authorized Representative.
   1. Contractor shall reimburse Owner’s Authorized Representative for loss of protected trees due to damage or lack of care.
   2. For protected trees injured, but not a complete loss to Owner’s Authorized Representative, the amount of penalty shall be determined by the Owner’s Authorized Representative.

B. All trees 24” box and larger, shall be guaranteed for one full year. Contractor shall warrant that all plants covered by the provisions of this Section will be in a healthy and flourishing condition of active growth 1 year from the date of Substantial Completion.

1. Guarantee boxed trees, to “live and grow” in an “acceptable, upright position after completion of the specified maintenance period and/or final acceptance. Definition of “live and grow” and “acceptable and upright position” shall mean that the tree must, during the guarantee period, sustain a healthy, vigorous appearance. It shall not defoliate more than 30% nor shall 30% of the foliage be dried and unhealthy in appearance. If the tree, during the guarantee period does not sustain this specified appearance, it shall be removed and replaced without cost to the Owner’s Authorized Representative.

C. All 15 gallon, 5 gallon, and 1 gallon shrubs and groundcovers shall be guarantee for 6 months from date of final acceptance.

D. Guarantees after completion of maintenance period and final acceptance will be contingent on the Owner’s Authorized Representative’s Representative proper continuation of maintenance program.

E. The Contractor, in protecting his own interests, is obligated to periodically check work areas during his guarantee period to insure proper maintenance procedures are being implemented. In case of negligent or improper maintenance, the contractor shall state in writing to the Owner’s Authorized Representative his observations and recommendations. Any claims not in writing will not be considered.

F. Should soil deficiencies affecting plant health develop within the specified guarantee periods, correct such deficiencies to the satisfaction of the Owner’s Authorized Representative at no additional cost.

1.7 VERIFICATIONS OF DIMENSIONS AND QUANTITIES

A. Verify scaled dimensions and quantities prior to start of work.

B. Notify the District Representative of discrepancies between Drawings and Specifications and actual job site conditions which would affect the execution of the landscaping work. Do not work in areas where discrepancies occur until instructed by the Owner’s Authorized Representative.

C. Plant quantities noted on Drawings are for the convenience of the Contractor only and do not limit the Contractor to those specific quantities. Furnish the quantities as may be necessary to do the specific work.

PART 2 PRODUCTS

2.1 IMPORTED SOIL, AMENDMENTS, AND FERTILIZERS

A. The following information on imported soil, soil amendments, fertilizers are to be used for establishing bid prices only. Specific amendments and fertilizer specifications will be made by the soils report after rough grading operations are complete and agronomic soil samples are collected and sent to the Soils lab for testing by the Contractor.

B. Import Top Soil: Silt plus clay content of the Import soil shall not exceed 20% by weight with a minimum 95% passing the 2.0 millimeter sieve. The sodium absorption ratio (SAR) shall not exceed 6 and the electrical conductivity (ECe) of the saturation extract of this soil shall not exceed 3.0 millimhos per centimeter at 25 degrees centigrade. The boron content shall be not greater than 1 part per million as measured on the saturation extract. In order to insure compliance with these specifications, samples of the import soil shall be submitted to an approved laboratory for analysis prior to, and following, backfilling.

C. Soil Amendments: All soil amendments shall be of standard approved and first-grade quality and shall be in prime condition when installed and accepted. Any commercially processed or packaged material shall be delivered to the site in the original unopened container bearing the manufacturer's guaranteed analysis. Provide The Owner’s Authorized Representative with a sample of all supplied materials within fourteen (14) days after award of contract, accompanied by analytical data from an approved laboratory source or bearing the manufacturer's guaranteed analysis. Amendments may be modified based on analysis provided.

Soil Amendments:

1. Soil Sulfur: Agricultural grade sulfur containing a minimum of 99% sulfur (expressed as elemental).

2. Iron Sulfate: 20% Iron (expressed as metallic iron), derived from ferric and ferrous sulfate, 10% sulfur (expressed as elemental).
3. Calcium Carbonate Lime: 95% lime as derived from oyster shells.
4. Gypsum: Agricultural grade product containing 98% minimum calcium sulfate.
5. Dolomite Lime:
6. 21% calcium
7. 11% magnesium
8. Nitrogen Fortified Wood Compost: Derived from Redwood, Fir or Cedar sawdust, or from the bark of Fir or Pine treated with a non-toxic agent to absorb water quickly and comply with the following requirements:
   a. Gradation

Sieve Size	Percent Passing
1/4-inch	95% minimum
#8	80% minimum
#35	30% maximum

   b. Nitrogen Content %, Dry Weight

Redwood	0.4 - 0.6%
Fir	0.56 - 0.84%
Cedar	0.56 - 0.84%
Fir Bark	0.8 - 1.2%
Pine Bark	0.8 - 1.2%

9. Salinity: Maximum saturation extract conductivity 2.5 millimhos/centimeter at 25 Celsius degrees.
10. Wettability: When one teaspoon of tap water is applied to 4 cubic inches of the air-dried products, the material shall become completely damp in a period not exceeding 2 minutes. (Greenways Environmental LLC, Pacific Mulch with Growpower, Kellogg KRA, Sequoia Redwood/Cedar blend or white fir, Long Beach soil prep, Bandini #1201 Redwood Soil Builder or nitrogenized wood amendment).

D. Fertilizer:
   1. Planting Fertilizer: Pelleted or granular form shall consist of the following percentage by weight and shall be mixed by commercial fertilizer supplier:
      6% nitrogen
      20% phosphoric acid
      20% potash
      38-0-0 slow release organic nitrogen.
   2. Commercial product containing 18- 20% available Phosphoric Pentoxide
   3. DAP (Di-Ammonium Phosphate): 18-46-0
   4. Planting Tablets:
      Shall be slow-released type with potential acidity of not more than 5% by weight containing the following percentages of nutrients by weight:
      20.0% nitrogen
      10.0% phosphoric acid
      5.0% potash
      2.6% combined calcium
      1.6% combined sulfur
      0.35% iron (elemental) from ferrous sulfate

E. Herbicide: Registered and approved by EPA post-emergent herbicide.

2.2 TREE PROTECTION FENCING:

A. Tree Protection Fence: As indicated on drawings.
   1. Install tree protection fencing around trees to be preserved at their drip line or at a minimum of 15' from the tree's trunk. Stands of trees may be fenced as a group. Fencing shall remain until landscape work has commenced, and it shall then be removed as directed by the Owner's Authorized Representative.

2. During the course of construction, relocation of the fence may be required to facilitate construction. The Contractor shall do so as directed by the Owner's Authorized Representative.

2.3 PLANT MATERIALS:

A. Plants shall be in accordance with the California State Department of Agriculture's regulation for nursery review, rules and rating. All plants shall have a normal habit of growth and shall be sound, healthy, vigorous and free of insect infestations, plant diseases, sunscalds, fresh abrasions of the bark, excessive abrasions, or other objectionable disfigurements. Tree trunks shall be sturdy and have well 'hardened' systems and vigorous and fibrous root systems which are not root or pot-bound. In case the sample plants reviewed are found to be defective, The Owner's Authorized Representative reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because of this review shall be considered as samples and shall be provided at the expense of the Contractor.

B. The size of the plants shall correspond with that normally expected for species and variety of commercially available nursery stock or as specified on drawings. The minimum acceptable size of all plants measured before pruning with the branches in normal position, shall comply with the measurements, if any, specified on the drawings in the list of plants to be furnished. Plants larger in size than specified may be used with the approval of The Owner's Authorized Representative, but the use of larger plants shall not change the contract price.

C. All plants not in compliance with the requirements herein specified, will be considered defective and such plants, whether in place or not, shall be marked as rejected and immediately removed from the site of the work and replaced with new plants at the Contractor's expense. The plants shall be of the species, variety, size, and conditions specified herein or as shown on the drawings. Under no conditions shall there be any substitutions of plants or sizes listed on the accompanying plans, except with the express consent of The Owner's Authorized Representative.

D. Pruning: At no time shall trees or plant materials be pruned, trimmed or topped prior to delivery and any alteration of their shape shall be conducted only with the approval and when in the presence of The Owner's Authorized Representative.

E. Plant material shall be true to botanical and common name and variety as specified in "Sunset Western Garden Book" (current edition).Nursery Grown and Collected Stock:

1. Plants shall be grown under climatic conditions similar to those in locality of project.

2.4 TREE STAKING MATERIALS:

A. Wood Tree Stakes for 30" Box and Smaller: Lodge pole pine fully treated with coppernapthanate wood preservative in strict accordance with Federal Spec. TT-W-572 Type 1 Composition B, 2" min. nominal size diameter x 10' long, no split stakes.

B. Tree Tie are to be VIT Twist Brace Tree Supports or approved equal, Two (2) per tree. TB24 Twist Brace for 15 gal.-24 inch box. Large size tree boxes per manufacturer recommendations. Install per Construction document detail.

C. Tree Root Barriers are to be #UB 48-2 Universal Barrier available from Deep Root Partners L.P. or approved equal.

2.5 PLANTER DRAINAGE GRAVEL

A. Drainage gravel is to be ¾" crushed gravel.

2.6 LANDSCAPE FABRIC

A. Weed barrier installed in all planters per Campus standards. Composite fabric Marafi 140N or District APPROVED EQUAL.

2.7 MULCH

A. Mulch shall be shredded redwood mulch.

1. A minimum of 4 inch layer of mulch is to be installed throughout all planters per Campus Standards under all trees, shrubs and groundcover areas.
   a. Keep a mulch ring 6 inches clear around all tree trunks and 3 inches clear around the central leader stem of each shrub.
2. Type: “Forest Floor ½ inch – 1 ½ inch or approved equal. The mulch shall consist of moist, fibrous, woody redwood bark mixture of varied particle size such that: Physical Properties: Particle Size ½ inch- 1 ½ inch.
3. Mulch is available from: Aguinaga Sales and Research Division
   16355 Construction Circle West, Irvine CA 9260
   www.aguinagagreen.com

B. Header shall be a steel edging, size 2” x 4” sections with stake at every 36" along the section; 12" long plastic stakes.
   1. Headers shall be furnished as shown on the drawings and herein specified. They shall be laid true to line and grade and in a workmanlike manner. Care shall be exercised in laying headers to project adjacent improvements, shrubbery and other properties from damage. All stakes shall be placed on ground cover side of headers. Install per plan and details.

C. Stabilized Decomposed Granite Gravel Mulch shall be rock particles placed in two layers as shown on the plans and as specified herein.
   1. Gravel mulch shall be crushed rock or decomposed granite, color per plan.
   2. Gravel mulch shall consist of fine materials, obtained from a single source and shall be approved for use by the Owner’s Authorized Representative.
   3. Crush Rock or Decomposed Granite shall conform to the following grading:

Screen Size	Percentage Passing (By Mass)
9.5 Millimeters	100
4.75 Millimeters	85-95
2.36 Millimeters	65-80
1.18 Millimeters	20-60
150 Micrometers	5-15

   4. Gravel mulch available from South West Boulder and Stone
   5. Stabilizer shall be integrated into Decomposed Granite by manufacture and installed per manufacturer’s recommendations.

D. Boulders type/color and size per Construction Legend.
   1. Boulders available from South West Boulder and Stone

PART 3 EXECUTION

3.1 PROTECTION OF TREES

A. Arborist shall identify the trees that must be protected.

B. Water: Provide sufficient water supply of potable quality and sufficient quantity for all operations required under this section. Water quantity to be carefully monitored during construction to maintain the health and vigor of the tree.

C. The existing trees to be preserved presently are in excellent condition. Trees shall not be allowed to deteriorate and shall be maintained in a healthy and vigorous condition during the course of construction and maintenance period.

D. During the course of construction the Contractor shall take all necessary precautions, as outlined herein, to protect the existing trees to be preserved from injury or death. Protection shall be given to the roots, trunk, and foliage of all existing trees to remain.

E. Trees subject to the provisions of this Section which have been injured shall be repaired immediately under the supervision of an approved, certified arborist. Repair may include removal of rough edges and sprung bark and severely injured branches as directed by the Owner's Authorized Representative.

F. Tree protection fencing shall be installed for the protection of existing trees to be preserved. No construction, demolition, or work of any nature will be allowed within the fenced area without prior written approval by the Owner's Authorized Representative.

1. Approval by the Owner's Authorized Representative for work within the fenced area shall not release the Contractor from any of the provisions specified herein for the protection of existing trees to be preserved.
2. During the course of construction of approved work within the fenced area, no roots larger than two (2) inches in diameter shall be cut without prior written approval by the Owner's Authorized Representative.

G. During construction the existing site surface drainage patterns shall not be altered within the area of drip line or in compliance with the development plans.

H. Contractor shall not alter the existing water table within area of drip line during rough grading unless directed by Owner's Authorized Representative.

I. Take necessary measures to maintain healthy living conditions for existing trees to be preserved. Such measures shall include but not be limited to periodic washing of leaves for the removal of dust, etc.

J. Do not permit the following within the drip line of any existing tree to be preserved:

1. Storage or parking of automobiles or other vehicles.
2. Stockpiling of building materials or refuse of excavated materials.
3. Skinning or bruising of bark.
4. Use of trees as support posts, power poles, or signposts; anchorage for ropes, guy wires, or power lines; or other similar functions.
5. Dumping of poisonous materials on or around trees and roots. Such material include but are not limited to paint, petroleum products, dirty water, concrete slurry, or other deleterious materials.
6. Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches, and other miscellaneous excavation without prior written approval by Owner's Authorized Representative.
7. Damage to trunk, limbs, or foliage caused by maneuvering vehicles or stacking material or equipment too close to tree.
8. Compaction of the root area by movement of trucks or grading machines; storage equipment, gravel, earth fill, or construction supplies, etc.
9. Excessive water or heat from equipment, utility line construction, or burning of trash under or near shrubs or trees.
10. Damage to root system from flooding, erosion, and excessive wetting and drying resulting from dewatering and other operations.

K. Excavation Around Trees

1. Excavation or fill within drip lines of trees shall be done only where absolutely necessary and with the direction of the Arborist.
2. Where trenching for utilities is required within drip lines, it shall be under the supervision and direction of the Arborist. Trenching within a tree's dripline area may require the use of hand tools.
3. Where excavation for new construction is required within drip line of trees, hand excavation under the supervision of the Arborist may be required to minimize damage to root system. Damaged roots or roots requiring removal that are larger than 2" diameter shall be cleanly cut by a hand saw. Cuts shall be made back to healthy root tissue.
4. Exposed roots and soil areas shall not be allowed to dry out before permanent backfill is placed. Temporary earth cover or organic mulch shall be provided, or roots shall be packed with wet peat moss or four layers of wet, untreated burlap and temporarily supported and protected from damage until permanently covered with backfill. The cover over the roots shall be wetted to the point of runoff daily.

5. Pruning may be required to balance loss to root system caused by damage or cutting of root system. Thinning shall not exceed 30 percent of existing foliage and shall be directed by the Owner's Authorized Representative.
6. Root Pruning: Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots with sharp pruning instruments; do not break or chop.

L. Pruning of Protected Tree
1. Trees which require pruning shall be inspected by Arborist, Owner's Authorized Representative and the Contractor before starting this work. All Pruning shall be in accordance with the standards of the International Society of Arboriculture or as directed by the Owner's Authorized Representative. All pruning shall be directed under the supervision of the Arborist.
2. The Owner's Authorized Representative and the Contractor's arborist will identify limbs and roots which are to be trimmed.
3. The Owner's Authorized Representative shall direct the removal of branches from trees and large shrubs which are to remain if required to clear for new construction.
4. Dead and damaged trees that are determined by the Owner's Authorized Representative and Arborist to be incapable of restoration to normal growth pattern shall be removed.
5. Cut evenly, using proper tools and skilled workmen, to achieve neat severance with the least possible damage to the tree.
6. In the case of root cuts, apply wet burlap or other protection, approved as noted herein, to prevent drying out, and maintain stem in a wet condition as long as necessary for temporary protection.

3.2 EXAMINATION

A. Review trees, shrubs and liner stock plant material for injury, insect infestation and trees and shrubs for improper pruning. Planting areas shall be free of concrete waste, asphalt, aggregate or other construction materials prior to start of installation.

B. Do not begin planting of trees until deficiencies are corrected or plants replaced.

C. Site Visits:
1. Site visits for review and review of work shall be scheduled with the Owner's Authorized Representative, and shall include, but not be limited to the following times:
   a. Review and test irrigation system.
   b. Review of fine grading operation, including planting areas and swales.
   c. Review of planting stock upon arrival to site or at nursery. Review of plant material placement for location prior to planting.
   d. Review of completed grading, irrigation and planting.
   e. Review at the completion of the maintenance period.
   f. Review at the completion of the warranty period.

3.3 PREPARATION

A. Soil Preparation (on grade areas):
1. If live weeds exist on site, strip and remove and replace top 1" of soil.
2. After approximate finished grades have been established, soil shall be conditioned and fertilized in the following manner. Soil should be slightly damp, but not muddy during rototilling.
   a. Prior to amending, the surface soil shall be cross ripped to a minimum nine (9) inch depth.
   b. The following shall be used for bidding purposes only. The contractor shall verify with the soil report prepared for the site specific amendments.
   c. Uniformly broadcast and blend to a six (6) inch depth:
      1) Organic amendment - 6 cu. yds.
      2) Planting fertilizer - 15 lbs.
      3) Agricultural gypsum - 200 lbs.
      4) Soil sulfur - 20 lbs.
      5) Urea formaldehyde - 8 lbs.

3. At time of planting, the top two inches of all areas to be planted shall be free of stones, stumps, earth clods, or other deleterious matter 1" in diameter or larger, and shall be free from all plastic, wire, plaster, obvious foreign matter or similar objects that would be a hindrance to planting or maintenance. The top 12" of soil shall be free of all stones, stumps or other deleterious matter 3" in diameter or larger.

B. Final Grades:
   1. Bring soil to grades as indicated on drawings, importing soils as necessary and anticipating the installation of soil amenders and settling and/or compaction.
   2. Finish grading shall insure proper drainage of the site as determined by the Owner's Authorized Representative
   3. .All areas shall be graded so that the final grades will be 1" below adjacent paved areas, sidewalks, valve boxes, headers, tree well grates, planter rims, clean-outs, drains, manholes, etc., or as indicated on plans for turf, and 1-1/2" for shrubs and ground covers.
   4. Surface drainage shall be away from all building foundations.
   5. Eliminate all erosion scars prior to commencing maintenance period.
   6. Compact all soil to final grades: min. 65%, max. 75%, unless otherwise required by soils report or direction from The Owner's Authorized Representative.

C. Disposal of Excess Soil: Dispose of any unacceptable or excess soil at an off-site location approved by the Owner's Authorized Representative.

3.4 INSTALLATION

A. General:
   1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practice as approved by the Owner's Authorized Representative.
   2. Only as many plants as can be planted on that same day shall be distributed in a planting area. All plants shall be watered within 2 hours of planting.
   3. Containers shall be opened and plants shall be removed in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as herein specified immediately after removal from the containers. Containers shall not be opened prior to placing the plants in the planting area.

B. Pre-Plant Weed Control:
   1. After soil preparation, irrigate and fertilize all planting areas for approximately 7-14 calendar days to achieve weed germination.
   2. If live weeds exist on site after irrigating and at the beginning of work, spray with a non-selective systemic contact herbicide, as recommended and applied by an approved licensed landscape pest control advisor and applicator. Leave sprayed plants intact for at least fifteen (15) days to allow systemic kill.
   3. Clear and remove all weeds by grubbing off all plant parts at least 1/4" below the surface of the soil to be planted.
   4. Repeat process as necessary, or as directed by the Owner's Authorized Representative.Do not plant until herbicide manufacturer indicates planting will not be affected by herbicide residue.
   5. Maintain site weed-free at all times. Degree of acceptability shall be solely determined by Owner's Authorized Representative.

C. Lay-Out of Major Plantings: Locations for container plants shall be spotted and outlines of ground cover areas to be planted shall be marked on the ground before any planting or excavation begins. All such locations shall be approved by The Owner's Authorized Representative. Layout shall be accomplished by setting container plants or grade stakes with plants identified in locations indicated on plans, and with gypsum lines for ground cover areas. If underground construction or utility lines are encountered in the excavation of planting areas, other locations for planting will be selected as approved by the Owner's Authorized Representative.

D. Planting of Trees and Shrubs:
   1. Excavate planting pits at twice the diameter of rootball with roughened surfaces and one and one half times the depth.

2. Prior to planting trees, fill planting hole with water to see if water drains in a reasonable time (approximately 4 hours). If drainage does not occur to the satisfaction of the District Representative, auger a 24 inch diameter hole, to a depth 12 inches above the water table but not exceeding 12 feet deep and fill with sand. Do not penetrate water table with drain hole.
3. The top of the rootball should be slightly above final grade.
4. Uniformly blend 2 lbs. of iron sulfate and 1/2 lb. planting fertilizer per cubic yard of backfill soil.
5. Organic material is not required in the backfill. A soil blend consisting of no more than 20% by volume organic matter shall be placed in the upper twelve (12) inches of backfill only. Soil below this depth shall not contain any organic matter.
6. Place slow release fertilizer tablets in the upper twelve (12) inches of backfill at manufacturers recommended rates.
7. Construct a two (2") inch water berm on the outside edge of rootball.
8. Cover the rootball with mulch.
9. Excess soil generated from the planting holes and not used as backfill or in establishing the final grades shall be removed from the site.
10. Install root barriers, as specified on plans
11. Protect all areas from excessive compaction when trucking plants or other material to the planting site. Cross rip all compacted areas to a 9 inch minimum depth except where existing tree roots of trees that are to remain as part of this work are evident.
12. Center plant in pit or trench.
13. Face plants with fullest growth into prevailing wind or as directed by The Owner's Authorized Representative.
14. Set plant plumb and hold rigidly in position until soil has been placed firmly around ball or roots.
15. All plants which settle deeper than the surrounding grade shall be raised to the correct level.
16. Box Removal: Remove bottom of plant boxes before planting. Remove sides of box without damage to rootball after positioning plant and partially backfilling.
17. Pruning: Pruning shall be limited to the minimum necessary to remove injured twigs and branches. Pruning may not be done prior to delivery of plants.
18. Staking: Staking of trees as directed by The Owner's Authorized Representative shall be completed immediately after planting. All stakes shall be installed plumb and as indicated on the Drawings per prevailing wind.

E. Planting of Groundcovers:
   1. Groundcover shall be planted in straight rows and evenly spaced, unless otherwise noted, and at intervals called out in the drawings. Triangular spacing shall be used unless otherwise noted on the drawings.
   2. Plantings shall be immediately sprinkled after planting until the entire area is soaked to the full depth of each hole.
   3. Care shall be exercised at all times to protect the plants after planting. Any damage to plants by trampling or other operations of this Contract shall be repaired immediately.

F. Mulch Cover: All groundcover, perennial, and annual beds to be dressed with 3" deep layer of mulch, (unless otherwise noted on plan.)

3.5 CLEANING

A. Leave the site area broom-clean daily leaving the premises in a clean condition. All walks shall be left in a clean and safe condition.

B. After all planting operations have been completed, remove all trash, excess soil, empty plant containers and rubbish from the property. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Pick up all trash resulting from this work no less frequently than each Friday before leaving the site or the last working day of each week. All trash shall be removed completely from the site.

3.6 SCHEDULES

A. When observations are conducted by someone other than The Owner's Authorized Representative, show evidence in writing of when and by whom these observations were made.

B. No site visits shall commence without all items noted in previous Observation Reports either completed or remedied unless such compliance has been waived by The Owner's Authorized Representative. Failure to accomplish punch list tasks or prepare adequately for desired observations shall make the Contractor responsible for reimbursing The Owner's Authorized Representative at his current billing rates per hour (plus transportation costs No further observations shall be scheduled until this charge has been paid and received.

END OF SECTION

SECTION 329700
LANDSCAPE MAINTENANCE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnish all labor, material, equipment and services required to maintain the landscape in an attractive condition as specified herein for a period of 90 calendar days. Contractor's bid shall include all materials and services referenced in the Drawings and these Specifications, and shall be responsible for review and completion all these specification instructions herein.

B. Related Sections:

1. Section 129300 - Site Furnishings
2. Section 321400 - Unit Paving
3. Section 328400 - Irrigation Systems
4. Section 329000 - Planting

1.2 SUBMITTALS

A. Submittals for review during construction phase:

1. Catalog cuts of all herbicides and fertilizers.
2. Prior to being placed on maintenance, submit a schedule of all activities planned during the maintenance period. This shall be accepted by the Owner's Authorized Representative prior to the start of the maintenance period. All schedule changes shall be documented and accepted by the College Representative.
3. The field set of "As-Built" drawings shall be available for review at the beginning of maintenance site walk
4. .Prior to date of the final walk-through, the Contractor shall acquire from the Owner's Authorized Representative a set of approved reproducible prints and produce the final record from the job record set of all changes made to all plans during construction, label said prints "As-Builts" and deliver to the College Representative, and as required to any Local Agency. Prior to the date of final inspection, deliver to the Owner's Authorized Representative the "Landscape and Irrigation Warranty" as required. Said Warranty shall be on the Contractor's letterhead and dated the scheduled final acceptance date.
5. All turnover items noted in other specification sections shall be delivered prior to the final walk-through.
6. Supply a monthly record of all herbicides, insecticides, fertilizers, and disease control chemicals with rates and amounts used noted.
7. Soils Report may adjust fertilizer rates and frequencies as noted herein.

1.3 QUALITY ASSURANCE

A. Installer Qualifications

1. Experience: The landscape establishment firm shall have a full time foreman assigned to the job for the duration of the contract. That person shall have a minimum of four (4) years' experience in landscape establishment and maintenance supervision, with experience or training in tree maintenance, entomology, pest control, soils, fertilizers, and plant identification.
2. Labor Force: The landscape establishment firm's labor force shall be thoroughly familiar and trained in the work to be accomplished and perform the task in a competent, efficient manner acceptable to the Owner's Authorized Representative.
3. Supervision: The foreman shall directly employ and supervise the work force at all times. Notify The Owner's Authorized Representative of all changes in supervision.
4. Identification: Provide proper identification at all times for landscape establishments firm's labor force. Be uniformly dressed in a manner satisfactory to the Owner's Authorized Representative.

5. The Owner's Authorized Representative shall have the right to make periodic inspections prior to final inspection. Should plant materials, installation procedures, or other conditions be observed that are not in accordance with the contract drawings or specifications, the Owner's Authorized Representative shall direct the Contractor to correct by repair and /or replacement as appropriate. The Owner's Authorized Representative shall be the sole judge of the conditions of quality and acceptability and will direct all corrections by the Contractor. All rejected materials shall be immediately removed from the site and replaced with specified materials at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials used shall either comply with the Landscape Planting Specifications or shall otherwise be acceptable to the Owner's Authorized Representative.

B. Maintenance Fertilizer shall consist of the following percentages by weight and shall be mixed by a commercial fertilizer supplier unless otherwise directed by The Owner's Authorized Representative or as specified agronomic soils report prepared by Wallace Labs, dated 6/16/2011 and any subsequent soils tests performed. .

PART 3 EXECUTION

3.1 APPLICATION

A. Tree and Shrub
   1. Watering: Maintain a large enough water basin around plants so that enough water can be applied to establish moisture through the major root zone. When hand-watering, use a water wand to break the water force.
   2. Staking: Remove stakes as soon as they are no longer needed. Stakes are to be inspected to prevent girdling of trunks or branches and to prevent rubbing that causes bark wounds. Replace all broken stakes and ties with specified materials.
   3. Weed Control: Keep basins and areas between plants free of weeds. Use recommended legally approved herbicides. Avoid frequent soil cultivation that destroys shallow roots. Use mulches to help prevent weed seed germination. All shrub and tree beds shall be kept weed-free.
   4. Insect and Disease Control: Maintain reasonable control with approved materials.
   5. Tighten all tree ties and guying as needed to keep trees growing in a straight upright position.

B. Fertilization:
   1. Fertilize all planting areas per recommendations listed in the agronomic soils report prepared by Wallace Labs, dated 6/16/2011 and any subsequent soils tests performed.
   2. After application, irrigate thoroughly.
   3. Avoid applying fertilizer to the root ball and base of main stem: rather, spread evenly under plant to drip line.

C. Replacement of Plants:
   1. Replace dead, dying and missing plants within one (1) week with plants of a size, condition and variety acceptable to the Owner's Authorized Representative at Contractor's expense.

D. Ground Cover Care:
   1. Weed Control: Control weeds with chemical systemic spray or by hand or mechanical means, so as to cause minimal damage to planted materials. All planted areas shall be kept trash and weed-free.
   2. Watering: Water enough so that moisture penetrates throughout root zone and only as frequently as necessary to maintain healthy growth. Do not over water.
   3. Fertilizing: Fertilize as specified agronomic soils report prepared by Wallace Labs, dated 6/16/2011 and any subsequent soils tests performed.
   4. Remove trash weekly.

5. Edge ground cover to keep in bounds and trim top growth as necessary to achieve an overall even appearance, unless directed by the Owner's Authorized Representative.
6. Repair all settlement conditions.

E. Irrigation System Care:
1. Check weekly all systems for proper operation. Lateral lines shall be flushed out after removing the last sprinkler head or two at each end of the lateral. All heads are to be adjusted as necessary for unimpeded coverage. Tree Bubblers and Low Flow Irrigation Systems shall be checked for clogging and flushed as needed per manufacturers recommendations.
2. Repair all damage to irrigation systems at the Contractor's expense. Repairs shall be made within one watering period.

3.2 ADJUSTING, CLEANING, AND PROTECTION

A. All areas shall be kept free of debris and all planted areas shall be weeded and cultivated at intervals of not more than ten (10) calendar days. Watering, mowing, rolling, edging, trimming, fertilization, spraying and pest control, as may be required, shall be included within the debris/siltation removal program. All area drains and drain pipes are to remain free of silt and debris.

B. The Contractor shall be responsible for maintaining adequate protection of the area. Damaged areas shall be repaired at the Contractor expense.

C. Between the 15th calendar day and the 20th calendar day of the maintenance period, replant all areas within the landscape that are not in vigorous, healthy conditions is not evident as determined by the Owner's Authorized Representative. Replenish any mulch areas not acceptable to the Owner’s Authorized Representative to the depth noted on the plans.

END OF SECTION

SECTION 331100
WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Requirements: Provide water distribution system, complete, as indicated on the Drawings or inferable therefrom and/or as specified in accordance with the Contract Documents.

1.2 SUBMITTALS

A. Product Data: Submit copies of manufacturer's specifications and installation instructions for each material. Include certification or other data verifying compliance with required characteristics. Indicate by transmittal form that copy of each has been distributed to the Installer.

B. Shop Drawings: Submit layout and shop drawings as required under Section Submittals. Include details of reinforced concrete structures.

C. Test Reports: Submit certified Test Reports showing compliance of the following items in accordance with Section General Conditions.
   1. Laboratory test for bedding and trench stabilization materials.
   2. Concrete design mix.
   3. Compression tests.
   4. Water Test Reports: Submit results of water sample tests by State or local health authorities.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. All work to be performed and materials to be used shall be in accordance with the Standard Specifications for Public Works Construction, latest edition and supplements.
   3. The Contractor shall have one copy of the Standard Specifications at the job site.
   4. The Standard Specifications apply only to performance and materials and how they are to be incorporated into the Work. The legal/contractual relationship sections and the measurement and pavement sections do not apply to this document.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

E. NSF Compliance:
   1. Comply with NSF 14 for plastic potable-water-service piping.
   2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.
      a. The lead content for domestic water systems shall be not more than 0.2 percent in respect to solder and flux and not more than a weighted average of 0.25 percent in respect to the wetted surface of pipes and pipe fittings, plumbing fittings and fixtures. Testing and listing of products to meet NSF/ANSI 61 Annex G and Section 116875 of the California Health and Safety Code.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect and Owner's Representative not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect and Owner's Representative written permission.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prevent damage to materials during loading, transportation, and unloading. Store equipment with moving parts off ground on platforms or skids.

1.6 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPE AND FITTINGS

A. **PVC, Schedule 40 (NPS 1/8 to NPS 3 ½):** ASTM D 1785. Suitable for potable water distribution and manufactured in compliance with NSF Standards.
   1. Fittings: PVC, Schedule 40 Socket Fittings: ASTM D 2466.

B. **PVC, AWWA Pipe (NPS 4 to NPS 12)**: AWWA C900, Class 200 DR 14, with bell-and-spigot or double-bell ends.
   1. PVC to PVC Fittings: Push-on-Joint, PVC Fittings, ASTM 3139, with elastomeric gasket bell ends, conforming to ASTM D2122 for bell measurements.
   2. PVC to Metal Fittings, Valves, and Accessories: Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts. Use corrosion resistant, high strength, low alloy steel, bolts and nuts where in contact with corrosive soil ASTM A 325.

2.3 VALVES

A. AWWA, UL/FM Cast-Iron, Gate Valves:
   1. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509 and UL/F.M. approved, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      a. Minimum Working Pressure: 200 pounds per square inch gauge (psig).
      b. End Connections: Flanged, push-on rubber gasketed, or mechanical joint, as required.
      c. Interior Coating: Complying with AWWA C550.

2.4 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," bottom section with base of size to fit over valve, and approximately five-inch diameter barrel. Fabricate valve box cover to fit snugly to prevent displacement by traffic.

1. Operating Wrenches: Steel tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Vertical-Type Indicator Posts: UL 789, FM-approved, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve with tamperproof electrical supervisory switch for connection to the fire alarm control panel system.

2.5 VALVE APPLICATION

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

1. Where specific valve types are not indicated, the following requirements apply:
   a. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated, gate valves with valve box.
   b. Underground Valves, NPS 4 and Larger, for Vertical-Type Indicator Posts: UL/FM, Cast-iron, nonrising-stem gate valves with indicator post.

2.6 CORROSION-PROTECTION ENCASEMENT FOR PIPING

A. Polyethylene Encasement for Underground Ductile-Iron Pipe and Fittings: Polyethylene encasement of 8 mils thickness shall conform to AWWA C105. Joint tape shall be self sticking PVC or polyethylene, 8 mils thick.

B. Fusion-Bonded Epoxy Coatings for Ductile-Iron and Gray-Iron Fittings: Epoxy coating shall conform to AWWA C116.

2.7 WATER METERS

A. Water meter(s) indicated on drawings shall be installed by the local water purveyor for the area, unless noted otherwise.

2.8 BACKFLOW-PREVENTION

A. General: FM Approved, AWWA, UL Classified, Approved by the Foundation for Cross Connection Control and Hydraulic Research at the University of Southern California.

1. Working Pressure: 175 pounds per square inch (psi) minimum, unless otherwise indicated.
2. Interior Components: Corrosion-resistant materials.
3. Exterior Components: Assembly shall be provided with flanged connections, galvanized cast-iron or epoxy coated construction.

B. Reduced-Pressure-Principle Backflow Preventers: Suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2, air-gap fitting located between two positive-seating check valves. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

2.9 FIRE DEPARTMENT CONNECTIONS

A. Exposed, Freestanding, Fire Department Connections: UL 405, cast-bronze body, with thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch high brass sleeve; and round escutcheon plate, and all appropriate check valves per NFPA 24.

1. Escutcheon Plate Marking: "AUTO SPKR."

PART 3 EXECUTION

3.1 INSPECTION

A. Examination: Examine substrates, adjoining construction and conditions under which Work is to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Field Measurements: Verify dimensions before proceeding with Work. Obtain field measurements for work required to be accurately fitted to other construction. Be responsible for accuracy of such measurements and precise fitting and assembly of finished work.

3.3 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
   2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.4 PIPING INSTALLATION

A. Project site water lines shall terminate approximately five feet from buildings, unless otherwise indicated on Drawings. Install temporary cap or plug terminals for future connection to building.

B. Bury piping with depth of cover over top at least 36 inches, unless otherwise indicated.

C. Comply with NFPA 24 for fire-service-main piping materials and installation.

D. Install PVC, AWWA pipe according to AWWA M23 and ASTM F 645.

E. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports for all lines NPS 3 or greater.

F. Water Main Connection: Arrange and pay for tap in the water main, water meter, and all associated fees from the water purveyor.

3.5 CLEARANCE OF WATER LINE

A. Building or Structure: 2 feet minimum horizontal separation.

B. Sewer crossing:
   1. Typical Conditions: Lay water mains over sanitary sewers to provide vertical separation minimum 3 feet.
   2. Unusual Conditions: If above separation cannot be met, for sewers less than 3 feet below the water pipe, use the following:
      a. Install water line with all joints located at least 4 feet from each side of the sewer pipe.
      b. Sewer pipe encased in six inches concrete around pipe, and extend 4 feet either side of water main.

C. Parallel to Sewer Line: Water line shall not be installed in a common trench with the building sanitary sewer unless both of the following requirements are met:
   1. The bottom of the water pipe, at all points, shall be at least 12 inches above the top of the sewer.
   2. The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a minimum clear horizontal distance of at least 12 inches from the sewer.

3.6 ANCHORAGE INSTALLATION

A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches for all lines NPS 3 or greater. Include anchorages for the following piping systems:
   1. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.

2. Fire-Service-Main Piping: According to NFPA 24.
3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. Vertical-Type Indicator Post Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

3.8 BACKFLOW-PREVENTER INSTALLATION

A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.

B. Do not install backflow preventers with relief drain in vault or other space subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support three-inch and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

E. Access and clearance shall be provided for the required testing, maintenance and repair. Access and clearance shall require a minimum of one foot between the lowest portion of the assembly and grade or platform.

F. Include tamperproof electrical supervisory switch for connection to tie the fire alarm control panel system.

3.9 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install fire department connections of types and features indicated.

B. Install ball drip valves at each check valve for fire department connection to mains.

3.10 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-service piping. Locate below finished grade, directly over piping. Refer to Division 31 Section "Earth Moving" for tape specifications.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: The piping shall be subjected for a minimum of two hours to a pressure of one and one-half times the working pressure, but in no case less than 150 pounds per square inch (psi). Examine all exposed pipe, joints, fittings and accessories during the test period. Replace or repair defective portions of the system, and repeat tests until results are satisfactory.

1. Allowable leakage shall be as specified in AWWA C-600, Table 3.

C. Prepare reports of testing activities.

3.12 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below:
    a. Fill system or part of system with water/chlorine solution containing at least 50 parts per million (ppm) of chlorine; isolate and allow to stand for 24 hours, or
    b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 parts per million (ppm) of chlorine; isolate and allow to stand for three hours.
    c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 333100
SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
   1. Cleanouts.
   2. Precast concrete manholes.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 SUBMITTALS

A. Manufacturer's product data for pipe and fittings.

B. Field quality-control test reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.4 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
   2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Shielded, Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   1. Diameter: Forty-eight inches, unless otherwise indicated.
   2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: Six-inch minimum thickness for floor slab and four-inch (100 millimeter) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
   5. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
   7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
   8. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
   9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
   10. Grade Rings: Reinforced concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
   11. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch minimum width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording "SANITARY SEWER."
      a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

2.6 CLEANOUTS

A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   1. Top-Loading Classification: Medium and Heavy duty.
   2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: Two percent through manhole unless otherwise noted.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: Four percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3,250 pounds per square inch (psi) minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
      a. Shielded flexible couplings for same or minor difference OD pipes.
      b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
      c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
   2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.2 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
   1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
   4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.

5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.3 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

3.4 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste and Vent Piping."

B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 pounds per square inch (psi).

3.5 FIELD QUALITY CONTROL

A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Allowable leakage is maximum of 50 gallons per inch of nominal pipe size per mile of pipe, during 24-hour period.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.
      f. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 pounds per square inch gauge (psig).
   6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
      a. Option: Test plastic gravity sewer piping according to ASTM F 1417.

B. Leaks and loss in test pressure constitute defects that must be repaired.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 334100
STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage pipe and drainage structures outside the building.

1.2 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.3 SUBMITTALS

A. Product Data: For each type of product installed.

B. Field quality-control test reports.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 CORRUGATED HIGH DENSITY POLYETHYLENE (HDPE) HDPE PIPE AND FITTINGS

A. HDPE Drainage Pipe and Fittings, NPS 4 to NPS 10: AASHTO M252, Type S, with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastometric seals.

B. HDPE Drainage Pipe and Fittings, NPS 12 to NPS 60: AASHTO M294, Type S, or ASTM F2306 with bell-and-spigot ends. Gasketed joints shall be soil-tight with ASTM F 477, elastometric seal.

2.4 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:
   a. Dallas Specialty & Mfg. Co.
   b. Fernco Inc.
   c. Logan Clay Products Company (The).
   d. Mission Rubber Company; a division of MCP Industries, Inc.
   e. NDS Inc.
   f. Plastic Oddities, Inc.

D. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:
   a. Cascade Waterworks Mfg.
   b. Dallas Specialty & Mfg. Co.
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Any equivalent manufacturer.

E. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

1. Available Manufacturers:
   a. Fernco Inc.
   b. Logan Clay Products Company (The).
   c. Mission Rubber Company; a division of MCP Industries, Inc.
   d. Any equivalent manufacturer.

2.6 CLEANOUTS

A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Available Manufacturers:
   a. Canplas Inc.
   b. IPS Corporation.
   c. NDS Inc.
   d. Plastic Oddities, Inc.
   e. Sioux Chief Manufacturing Company, Inc.
   f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2.7 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Diameter: 48 inches minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: Four-inch minimum thickness, and of length to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990 bitumen or butyl rubber.
7. Retain first subparagraph below unless not required.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, one-half inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Retain one of first two subparagraphs below if required.
11. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
12. Grade Rings: Reinforced-concrete rings, six- to nine-inch total thickness, to match diameter of manhole frame and cover.
13. Manhole Frames and Covers: Ferrous; 24-inch ID by seven- to nine-inch riser with four-inch-minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording "STORM DRAIN."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron or ASTM A 48, Class 35 gray iron, unless otherwise indicated.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.
5. Portland cement design mix, 3250-psi minimum, with 0.45 maximum water-cementitious materials ratio.
    a. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
    b. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Base Section: Six-inch minimum thickness for floor slab and four-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Top Section: Eccentric-cone type unless flat-slab-top type is indicated.
3. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16 (heavy traffic) structural loading unless otherwise indicated. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
    a. Shielded flexible couplings for same or minor difference OD pipes.
    b. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.2 PIPING INSTALLATION

A. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

B. Install manholes for changes in direction if shown on plan, otherwise use fittings. Use fittings for branch connections unless direct tap into existing sewer is indicated.

C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

D. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of one percent, unless otherwise indicated.
   2. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

E. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
   3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
   4. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops three inches above finished surface elsewhere, unless otherwise indicated.

3.5 CATCH BASIN INSTALLATION

A. Set frames and grates to elevations indicated.

3.6 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

B. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus six-inch overlap, with not less than six inches of concrete with 28-day compressive strength of 3,250 psi.

3.7 FIELD QUALITY CONTROL

A. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.

3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Hydrostatic Tests: Test sewers according to requirements of authorities having jurisdiction and the following:
    a. Allowable leakage is maximum of 50 gallons per inch of nominal pipe size per mile of pipe, during 24-hour period.
    b. Close openings in system and fill with water.
    c. Purge air and refill with water.
    d. Disconnect water supply.
    e. Test and inspect joints for leaks.
6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.
7. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Option: Test plastic gravity sewer piping according to ASTM F 1417.

B. Leaks and loss in test pressure constitute defects that must be repaired.

C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 334600
SUBDRAINAGE

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes subdrainage systems for foundations, underslab areas, retaining walls and other subdrainage systems.

1.2 SUBMITTALS

A. Product Data: For perforated pipe, fitting and drainage panel.

PART 2 PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated plastic pipe shall be either smooth-wall polyvinyl chloride plastic pipe, corrugated polyvinyl chloride plastic pipe with a smooth interior surface, or corrugated polyethylene plastic tubing.
   1. Smooth-wall polyvinyl chloride plastic pipe shall conform to the requirements in AASHTO Designation: M 278.
   2. Corrugated polyvinyl chloride plastic pipe with a smooth interior surface shall conform to the material and structural requirements in AASHTO Designation: M 278. The pipe shall have perforations located in the bottom half of the pipe, and the perforations shall consist of slots meeting the size and opening area requirements in AASHTO Designation: M 252. The inside diameter and diameter tolerances shall conform to the requirements of either AASHTO Designation: M 252 or M 278.
   3. Corrugated polyethylene plastic tubing shall conform to the requirements in AASHTO Designation: M 252 or M 294.

2.2 PERFORATIONS

A. Perforations per ASTM F 758, section 7.2.4. and Table 5.
   1. NPS 4: Two rows of perforations.
   2. NPS 6 and 8: Four rows of perforations
   3. NPS 10 and larger: Six rows of perforations.

2.3 FITTINGS

A. Polyvinyl chloride pipe shall be connected with belled ends, or with sleeve-type or stop-type couplings conforming to the requirements in AASHTO Designation: M 278. Polyethylene tubing shall be connected with snap-on, screw-on, or wrap-around fittings and couplings conforming to the requirements of AASHTO Designation: M 252 or M 294. Solvent cementing of joints will not be required.

2.4 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
   1. Shielded Flexible Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

2.5 DRAINAGE PANELS

A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, 36 to 60 inches wide with drainage core faced with geotextile filter fabric.
   1. Manufacturers:
      a. American Wick Drain Corporation – Amerdrain.
      b. Cosella-Dorken.
      c. CCW – MiraDrain.
      d. Eljen Corp.
      e. Greenstreak, Inc.
      f. JDR Enterprises, Inc.
      g. LINQ Industrial Fabrics, Inc.
      h. Midwest Diversified Technologies Incorporated.
      i. TC Mirafi.
      j. Any equivalent manufacturer.
   2. Prefabricated Drainage Core: Three-dimensional, nonbiodegradable, molded PP or PS. Select prefabricated drainage core recommended by the manufacturer for the type of application specified elsewhere in the contract documents.
      a. Minimum Compressive Strength: 10,000 pound force (lbf)/square foot according to ASTM D 1621.
      b. Minimum In-Plane Flow Rate: 10 gallons per minute/foot according to ASTM D-4716
   3. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties:
      a. Grab Elongation: 60 percent maximum according to ASTM D-4632.
      b. Apparent Opening Size: No. 70 sieve, minimum according to ASTM D-4751.
      c. Water Flow Rate: 165 gallongs per minute (gpm)/square foot according to ASTM D-4491.

2.6 SOIL MATERIALS

A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 2 Section "Earthwork."

2.7 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gallons per minute (gpm)/square foot when tested according to ASTM D 4491.
   1. Structure Type: Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.
   2. Style(s): Flat and sock.

PART 3 EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING APPLICATIONS

A. Underground Subdrainage Piping:
   1. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Header Piping:
   1. PVC sewer pipe and fittings, couplings, and coupled joints.

3.3 FOUNDATION DRAINAGE INSTALLATION

A. Install vertical drainage panels per manufacturer’s installation instruction and details or as follows:
   1. Coordinate placement with other drainage materials.
   2. Separate four inches of fabric at beginning of roll and cut away four inches of core. Wrap fabric around end of remaining core.

3. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. Place nails from two to six inches below top of panel, approximately 48 inches apart. Construction adhesives, metal stickpins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
4. If additional panels are required on same row, cut away four inches of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
5. If additional rows of panels are required, overlap lower panel with four inches of fabric.
6. Cut panel as necessary to keep top 12 inches below finish grade.
7. For inside corners, bend panel. For outside corners, cut core to provide three inches for overlap.

B. Place initial backfill material over compacted drainage course. Place material in loose-depth layers not exceeding six inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
3. Lay perforated pipe with perforations down.
4. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

B. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties..

B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.

C. Where required, connect low elevations of foundation subdrainage to stormwater sump pumps.

3.7 FIELD QUALITY CONTROL

A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.8 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION

SECTION 334923
POLYMER CORRUGATED METAL PIPE (CMP)
UNDERGROUND DETENTION AND INFILTRATION

PART 1 GENERAL

1.1 SUMMARY

A. This item shall govern the furnishing and installation of Underground Detention and Infiltration Systems for all types, sizes and designations as shown on the plans.

B. Contractor shall furnish all labor, materials, equipment and incidentals necessary to install the CMP System, appurtenances and incidentals in accordance with the Drawings and as specified herein.

C. A stormwater treatment device upstream of the CMP System is recommended as the appropriate means of pretreating for the purpose of extending the maintenance interval on the CMP System and reducing the life cycle cost. Both engineered solutions shall be provided by a single supplier/manufacturer. Filtration by wrapping a system with geotextile is not an acceptable means of pretreatment.

D. Applicable provisions of any Division shall govern work in this section.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASTHO Design Section 12 – Soil-Corrugated Metal Structure Interaction Systems
   2. AASHTO Construction Section 26 – Metal Culverts
   3. AASHTO M245 – Standard Specification for Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains
   4. AASHTO M246 – Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated, for Corrugated Steel Pipe

B. American Society for Testing and Materials (ASTM)
   1. ASTM A742: Standard Specification for Steel Sheet, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe
   2. ASTM A762: Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
   3. ASTM A798: Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
   4. ASTM A998: Standard Practice for Structural Design of Reinforcements for fittings in Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

1.3 SUBMITTALS

A. Site layout drawings, product specifications, materials, corrugation, gage, hydraulic storage data and supported calculations of proposed alternatives shall be submitted to the EOR for review at a minimum of 10 working days prior to bid closing.

B. Shop drawings shall be annotated to indicate all materials to be furnished and installed under this section, and all applicable standards for materials, required tests of materials and design assumptions for structural analysis:
   1. Before installation of the CMP System, Contractor shall obtain the written approval of the EOR for the stormwater system and the installation drawings.

1.4 QUALITY ASSURANCE

A. All proposed alternatives to the CMP System shall conform to applicable above referenced AASHTO and ASTM specifications. NCSPA provides design service life guidance for certain products up to 100 years in recommended environments.

PART 2 PRODUCTS

2.1 MATERIALS

A. Polymer coated material shall conform to the applicable requirements of AASHTO M264 or ASTM A742. CMP shall be manufactured in accordance with the applicable requirements of AASHTO M245 or ASTM A762.

B. The pipe sizes, gauges and corrugations shall be as shown on the project plans. Joint performance requirements are published in Division II, Section 26.4.2, of the current edition of the AASHTO Bridge Construction Specifications.

C. Soil tight, gravity flow, non-pressure, drainage pipe joints shall conform to AASHTO M245 and ASTM A762. Minimum joint spacing shall be 10 ft.

D. Overlapping of adjacent pipes are not permitted and appropriate banding must be utilized in order to properly secure individual pipes in place.

E. Integral End Sections: Each barrel of the CMP System shall either be connected to a fitting composing a manifold for hydraulic distribution or have an integrated bulkhead to resist loading at the end/start of the barrel, end cap sections shall not be permitted.

F. Material selected shall be flame resistant and capable of retaining 80% of strength when subjected to a temperature of 400 degrees Fahrenheit for one hour.

2.2 FABRICATION

A. All fittings shall be manufactured prior to arriving on the jobsite to ensure structural integrity. Fitting reinforcement shall be in accordance with ASTM A998 and reinforcing details.

B. The manufacturer of the CMP System shall be one that has regularly been engaged in the engineering design and production of these systems for at least fifteen (15) years and which has a history of successful production, acceptable to the EOR. In accordance with the Drawings, the CMP System shall be supplied by:

Contech Engineered Solutions
9025 Centre Pointe Drive
West Chester, OH, 45069
Tel: 1 800 338 1122

C. Sampling, testing, and inspection of metal sheets and coils used for manufacturing the CMP System shall be in accordance with to the above applicable referenced specifications. All fabrication of the product shall occur within the United States.

PART 3 PERFORMANCE

3.1 DESIGN

A. The CMP System proposal shall be sized in accordance to the design provided and approved by the Engineer of Record (EOR). Any Contractor deviating from the design shown on the plans, to include: material, footprint, etc., shall provide to the EOR a summary report on stage-storage curves, design calculations, HydroCAD modeling and engineering drawings.

B. The CMP System shall comprise of manhole access with minimum dimensions of 24 inches diameter to provide adequate inspection and maintenance without restrictions and obstructions to entry into interior of the CMP System. Manholes shall be provided to allow full entry into and visual inspection of the complete CMP System, at a minimum as to allow full maintenance of the CMP System. Cleanouts or inspection ports are not acceptable access points for maintenance and inspection nor are any other alternatives which do not allow for full entry into the system.

C. CMP spacing, gage (thickness) and stone base thickness can be altered with consultation from Contech Engineered Solutions, LLC.

D. The CMP System shall be designed for a minimum HS20-44 final live loading conditions. The CMP System shall meet HS20-44 loading requirements with a minimum of 12-inches of cover to bottom of flexible pavement for pipe spans less than or equal to 96 inches and 18 inches of cover to bottom of flexible pavement for pipe spans greater than 96 inches.

E. The CMP System shall be designed so as the hydraulic grade line will increase evenly throughout whereas transverse movement from one storage compartment to another shall not be permitted. All storage compartments shall be connected via manifold (or connecting pipe) versus by transporting stormwater through stone.

F. A stormwater pretreatment device is recommended upstream of the CMP system as follows:

5. Detention: Where feasible, the selected Stormwater treatment device upstream of a detention system shall be a separator system and have GULD for Pretreatment by the WADOE or demonstrate equivalent performance in independently verified field testing following a peer reviewed testing protocol, and must be sized consistent with the system producing those results.
6. Selected pretreatment stormwater device shall incorporate a physical barrier capable of capturing and retaining trash and debris (i.e.: floatable and neutrally buoyant materials) for all flows up to the treatment capacity of the device.
7. The application of wrapping a system with geotextile of any branding or material type, that allows the passage of stormwater, shall not be regarded as an acceptable treatment or pretreatment device.
8. The manufacturer of the selected Stormwater treatment device shall have been regularly engaged in the engineering design and production of systems for the physical treatment of Stormwater runoff for 15 years.
9. In order to not restrict the Owner's ability to maintain the stormwater pretreatment device, the minimum dimension providing access from the ground surface to the sump chamber shall be 20 inches in diameter.

PART 4 EXECUTION

4.1 INSTALLATION

A. The CMP System installation shall be in accordance with AASHTO Standard Specifications for Highways Bridges, Section 26, Division II or ASTM A798 and in conformance with the project plans and specifications.

B. The CMP System shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. Handling & assembly shall be in accordance with National Corrugated Steel Pipe Association's (NCSPA) recommendations.

C. For temporary construction vehicle loads, an extra amount of compacted cover may be required over the top of the pipe. The Height-of-Cover shall meet the minimum requirements shown in the table below. The use of heavy construction equipment necessitates greater protection for the pipe than finished grade cover minimums for normal highway traffic.

Minimum Cover (ft) Requirements

Pipe Span (inches)	Axle Loads (kips)			
	18 - 50	50 - 75	75 - 110	110 - 150
12 - 42	2.0	2.5	3.0	3.0
48 - 72	3.0	3.0	3.5	4.0
78 - 120	3.0	3.5	4.0	4.0
126 - 144	3.5	4.0	4.5	4.5

G. Minimum cover may vary, depending on local conditions. The contractor must provide the additional cover required to avoid damage to the pipe. Minimum cover is measured from the top of the pipe to the top of the maintained construction roadway surface.

H. The contractor shall follow Occupational Safety and Health Association (OSHA) guidelines for safe practices in executing the installation process in accordance with the manufacturer/supplier installation recommendations.

I. Backfill material shall be placed in 8 inch loose lifts and compacted to 90% AASHTO T99 standard proctor density.

J. Supplier will conduct an on-site preconstruction meeting with the contractor prior to the scheduled delivery date of the CMP System.

END OF SECTION