SECTION 260000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section includes general requirements specifically applicable to Divisions 26, and 27; including requirements form Division 1.

1.2 RELATED SECTIONS

A. All included sections under Division 1
B. All included sections under Division 26
C. All included sections under Division 27
D. Plans
E. Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A. Standards
   1. AEIC – Association of Edison Illuminating Companies
   2. ANSI – American National Standards Institute
   3. ASTM – American Society of Testing and Materials
   4. CBM – Certified Ballast Manufacturers Association
   5. EIA – Electronic Industry Association
   6. ICEA – Insulated Cable Engineers Association
   7. IEEE – Institute of Electrical and Electronics Engineers
   8. NEMA – The Association of Electrical and Medical Imaging Equipment Manufacturers
   9. FM - Factory Mutual
   10. UL – Underwriter's Laboratory's, Inc., Standards for Safety

B. Local codes and authorities having jurisdiction
   1. City codes
   2. County codes
   3. Local fire department

C. State codes and authorities having jurisdiction
   1. CBC – California Building Code
   2. CEC – California Electrical Code
   3. State of California Codes

D. National codes and authorities having jurisdiction
   1. NESC – National Electrical Safety Code
   2. OSHA – Occupational Safety and Health Act

E. Utilities
   1. Local cable company
   2. Local electrical company
   3. Local telephone company

F. Code compliance
   1. All work and materials shall comply with the latest rules, codes, and regulations, including, but not limited to the following:
      a. Occupational Safety and Health Act Standards (OSHA).
      b. CCR, Title 24, Part 3: California Electrical Code (CEC)
      c. All other applicable Federal, State and Local laws and regulations.
   2. Code compliance is mandatory. Nothing in these Drawings and Specifications permits work not conforming to National, State, and Local electrical and building codes. Where work is shown to exceed minimum code requirements, comply with Drawings and Specifications.

3. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the Contractor shall be responsible for opening the concealed areas, making any required corrections and/or modifications to his work, and restoring the area to its previous condition.

1.4 DEFINITIONS (APPLICABLE TO DRAWINGS AND SPECIFICATIONS)

A. Provide: To supply, install, and connect complete and ready for safe and regular operation of work referred to unless specifically otherwise noted
B. Install: To erect, mount and connect complete with related accessories
C. Supply: To purchase, procure, acquire, and deliver complete with related accessories
D. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation
E. Wiring: Raceway, fittings, wire, boxes, related items, and connection
F. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.
G. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms; in general, any item that is directly accessible without removing panels, walls, ceiling, or other parts of structure.
H. Indicated, Shown, or Noted: As indicated, shown, or noted on drawings or specifications
I. Above Grade: Not buried in ground or embedded in concrete slab on ground
J. Below Grade: Buried in ground or embedded in concrete slab on ground
K. Underground: Buried in ground, including under building slabs
L. Connect: Complete hookup of item with required services, including conduit, wire, and other accessories
M. Furnish: Supply and deliver complete
N. Similar or Equal: Of base bid manufacturer, equal in materials, weight, size, design, and efficiency of specified product; equivalent to Base Bid Manufacturer's product
O. Reviewed, Satisfactory, Accepted, or Directed: As reviewed, satisfactory, accepted, or directed by or to engineer
P. Contractor: Electrical Sub Contractor unless stated otherwise
Q. Use (verb): Furnish and install as defined above

1.5 LICENSES, FEES, AND PERMITS

Pay for all City, County, or State electrical licenses, fees, and permits. Arrange for all required inspections by agencies or authorities having local jurisdiction. The owner shall pay for all inspection fees and permits.

1.6 CONDITIONS AT SITE

A. A visit to the site is required of all bidders prior to submission of bid. All will be held to have familiarized themselves with all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
B. Underground or overhead lines or other services that are damaged as a result of this work shall promptly be repaired at no expense to the Owner and to complete satisfaction of the Owner.

1.7 DRAWINGS AND SPECIFICATIONS

A. All Drawings and all Divisions of these Specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.

B. The Contract Drawings are diagrammatic and indicate the general arrangement of equipment and wiring. Most direct routing of conduit and wiring is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other Drawings in preparation of the bid. Extra lengths of wiring or addition of pull or junction boxes, etc., necessitated by such conditions shall be included in the bid. Check all information and report any apparent discrepancies before submitting bid.

C. Right is reserved to make change up to ten (10) feet in location of any outlet, device, or equipment prior to roughing in without increasing contract cost.

D. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable codes, whether or not each piece of conductor, conduit, or protective device is shown between items of equipment or fixtures and the point of circuit origin.

1.8 SAFETY AND INDEMNITY

A. Safety: The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all people and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.

B. No act, service, drawing review, or construction review by Owner, Architect, Engineers, or their Consultants is intended to include review of the adequacy of the Contractor's safety measures in, on, or near the construction site.

1.9 RECORD DRAWINGS

A. Submit record Drawings under provisions of Section 013000.

B. Submit prior to final acceptance inspection, one complete marked-up set of reproducible engineering design Drawings.
   1. Fully illustrate revisions made by crafts in course of work.
   2. Include field changes, adjustments, variances, substitutions, and deletions, including Change Orders.
   3. Indicate exact location of raceways, equipment, and devices.
   4. Indicate exact size and location of underground and under floor raceways, grounding conductors, and duct banks.
   5. The record Drawings shall show all the work actually constructed and originally shown on the Drawing based upon the field construction by the Contractor.

C. These Drawings shall be for record purposes for Owner's use and are not considered Shop Drawings.

1.10 MANUFACTURER'S INSTRUCTIONS

A. Where the Specifications call for an installation to be made in accordance with manufacturer's recommendations, a copy of such recommendations shall continuously be kept in the job superintendent's office and shall be available to the Owner's representative.

B. Follow manufacturer's instructions where they cover points not specifically indicated on Drawings and Specifications. If they are in conflict with the Drawings and Specifications, obtain clarification from the Architect or Engineer before starting work.

C. One (1) set of equipment manufacturer's Drawings shall be submitted to the Engineer for their record.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Operating and maintenance manuals and close-out documents are used interchangeably

B. Submit operating and maintenance manuals of equipment in the following format. Owner shall decide which format they prefer.
   1. Three (3) hardcopy sets

2. PDF format

C. For specific requirements, see the sections in which the equipment is specified.

1.12 QUALITY ASSURANCE

A. Provide a meaningful quality assurance program. To assist the Contractor in this program, the Specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating facility within the scope of this project.

B. The Contractor shall ensure that workmanship, materials employed, required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.

1.13 GUARANTEE

Guarantee the installation free from defects of workmanship and materials for a period of one (1) year after Date of Certificate of final payment and promptly remedy any defects developing during this period, without charge.

1.14 BIDDING

A. The contractor shall bid on the plans, specifications, etc. that constitute the contract documents.

B. The contractor shall not attempt to modify the contract documents without the approval of the electrical engineer.

C. All “value engineering” proposals shall be submitted to the electrical engineer in writing.

D. If the contractor makes changes to the contract documents not approved by the electrical engineer, the contractor will still be responsible for installing all devices, conductors, conduits, etc. the contract documents call for.

1.15 ABBREVIATIONS

AES	Advanced Encryption Standard
AIC	Amps interrupting capability
ANSI	American National Standards Institute
ASTM	ASTM International, formerly American Society for Testing and Materials
CAD	Computer aided design
CATV	Cable television
CBC	California Building Code
CCTV	Closed circuit television
CEC	California Electrical Code
CFC	California Fire Code
CFR	Code of Federal Regulations
CSFM	California State Fire Marshal
DPDT	Double pole, double throw
DPST	Double pole, single throw
DSA	Division of the State Architect
EIA	Electronic Industries Association
EMT	Electrometallic conduit
EOR	Engineer of record
FACP	Fire alarm control panel
FMC	Flexible metallic conduit
GRS	Galvanized, rigid steel conduit
ICC-ES	International Code Council Evaluation Service

IDF	Intermediate data frame
IEC	International Electrotechnical Commission
IED	Intelligent electronic device
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society of North America
IMC	Intermediate metallic conduit
I/O	Input/output
IOR	Inspector of record
IP	Internet protocol
ISO	International Organization for Standardization
LAN	Local area network
LCD	Liquid crystal display
LCP	Lighting control panel/lighting relay panel
LED	Light emitting diodes
MDF	Main data frame
NEC	National Electrical Code
NEMA	Association of Electrical Equipment and Medical Imaging Manufacturers
NETA	National Electrical Testing Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NIST	National Institute of Standards and Technology
OCPD	Overcurrent protection device
PDF	Portable document format
PVC	Polyvinyl chloride
SCCR	Short circuit current rating
SHA	Secure Hash Algorithm
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SPD	Surge protective device
SPDT	Single pole, double throw
SPST	Single pole, single throw
TFT	Thin film transistor
THD	Total harmonic distortion
TIA	Telecommunications Industries Association
UL	Underwriters' Laboratories
USB	Universal series bus
UPS	Uninterruptable power supply
VFD	Vacuum fluorescent display
VOIP	Voice over Internet protocol
VPN	Virtual private network
WAN	Wide area network

PART 2 – PRODUCTS

2.1 MATERIAL APPROVAL

A. All materials must be new and bear Underwriters' Laboratories label. Materials that are not covered by UL testing standards shall be tested and approved by an independent testing laboratory or a governmental agency.

B. Material not in accordance with these Specifications may be rejected either before or after installation.

C. Materials or equipment specified by:
   1. Name of manufacturer.
   2. Brand or trade name.
   3. Catalog reference.

2.2 SUBSTITUTIONS

A. Base the bid on use of materials specified.
B. Equipment other than specified will be considered for approval provided it meets previous items A through C and the following is submitted in writing by the Contractor to the Engineer to allow approval at least 14 days before the bid date:
    1. The request for permission to substitute shall be accompanied with a statement of the amount of money to be returned to the contract if the substitution is permitted.
    2. Return a completed request for substitution form.
C. The engineer is the sole judge of acceptability of preferred substitutions.
D. If a substitute is permitted, and any re design effort is thereby necessitated, the required re design shall be at the Contractor's expense.

2.3 SUBMITTALS

Submit to architect, or engineer if no architect is involved, seven (7) copies of complete Shop Drawings and materials lists, as noted below, for review within thirty (35) days after award of contract. All proposed deviations from Specifications must be clearly listed and submitted separately under a prominent heading entitled "Substitutions."

A. Fire Alarm Systems
B. Communication Systems
C. Pull Boxes and Cabinets
D. Conduit and Wire
E. Service and distribution
F. Transformers

2.4 OPERATING AND MAINTENANCE MANUALS

Submit Operating and Maintenance Manuals of equipment as specified under Division 1. Verify exact quantity with architect, or engineer if no architect is involved.

2.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be shipped in its original packages, to prevent damaging or entrance of foreign matter. Handling and shipping shall be performed in accordance with manufacturer's recommendations. Provide protective covering during construction.
B. Replace at no expense to Owner, equipment or material damaged during the storage or handling, as directed by the engineer.
C. Equipment shall be tagged with a weatherproof tag identifying equipment by name and purchase order number. Packing and shipping lists shall be included.

PART 3 – EXECUTION

3.1 CLEARANCE

Minimum code required clearances for electrical equipment shall not be violated.

3.2 WORKMANSHIP AND CONTRACTOR'S QUALIFICATIONS

A. Only quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.
B. The Electrical Contractor shall provide a Superintendent in charge of this work at all times to direct the quality of the installation.

3.3 COORDINATION

A. Coordinate work with other trades to avoid conflict and to provide correct rough in and connection for equipment furnished under other trades and requiring electrical connections. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
B. Verify equipment dimensions and requirements with provisions specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation and agreed price shall be at Contractor's risk and expense.
C. Provide temporary feeds and connections to areas and equipment as required to allow phased construction and operation.

3.4 CUTTING AND PATCHING

All cutting and patching required for work of this Division is included herein. Coordination with General Contractor and other trades is imperative. Contractor shall bear the responsibility for and bear the added expense of adjusting for improper holes, supports, etc.

END OF SECTION

REQUEST FOR SUBSTITUTION

To: _____

A. _____ submits for your consideration the following product instead of the specified item:

1. Project: _____
2. Section or Sheet: _____, Article or Paragraph: _____
3. Specified Item: _____
4. Proposed Substitution (Mfg., Type, Model, etc.): _____
   _____

B. Complete all of the following:

1. Does this substitution offer the Owner a cost credit (including costs for changes by other trades)? _____ How much? _____
2. Does this substitution offer earlier delivery or less construction time? _____
   How much? _____ How so? _____
3. How does the substitution affect any dimensions, layout, or details of other trades as shown on the Drawings? _____
   _____
   _____
4. What are the specific differences between this substitution and the specified item?
   _____
   _____
   _____

C. Attach the following items.

1. Manufacturer's technical data _____
2. Laboratory test or performance results _____
3. Drawings and wiring diagrams of the proposed product _____
4. Drawings and description of changes required by other trades _____
5. Manufacturer's guarantee and maintenance instructions _____

D. The undersigned agrees to pay for all additional review, design, testing, changes in contract documents, and construction as a result of the acceptance of this substitution, at no cost to the Owner.

E. Submitted by (Firm) _____

Print name _____

Signature_____ Date _____

Accepted ☐ Rejected ☐ Revise and Resubmit ☐ See Attached ☐

END OF REQUEST FOR SUBSTITUTION

SECTION 260500

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SECTION INCLUDES

Materials, equipment fabrication, installation, and tests in conformity with applicable codes and authorities having jurisdiction, for the following:

A. Conduit and raceways
B. Wire and cables
C. Outlet boxes
D. Junction boxes
E. Pull boxes
F. Grounding

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. All included sections under Division 1
B. All included sections under Division 26
C. All included sections under Division 27
D. Plans
E. Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

Published specification standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.

A American Society for Testing and Materials
   1. ASTM B3: Standard Specification for Soft or Annealed Copper Wire
   2. ASTM B33: Standard Specification for Tin-Coated or Annealed Copper Wire for Electrical Purposes
   3. ASTM B738: Standard Specification for Fine-Wire Bunch-Stranded and Rope-Lay Bunch-Stranded Copper Conductors for Use as Electrical Conductors
   4. ASTM B355: Standard Specification for Nickel-Coated, Soft or Annealed Copper Wire
   5. ASTM D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

B. California Electrical Code (CEC)

C. Institute of Electrical and Electronic Engineers (IEEE)
   1. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
   2. IEEE 82: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
   3. IEEE 95: Standard Test Procedure for Impulse Voltage Tests on Insulated Conductors
   4. IEEE 141: Recommended Practice for Electric Power Distribution for Industrial Plants
   5. IEEE 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
   6. IEEE 241: Recommended Practice for Electric Power Systems in Commercial Buildings
   7. IEEE 242: Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
   8. IEEE 399: Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book)
   9. IEEE 442: Guide for Soil Thermal Resistivity Measurements

10. IEEE 576: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
11. IEEE 1185: Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities
12. IEEE 1584: Guide for Performing Arc Flash Hazard Calculations
13. IEEE 1584a: Guide for Performing Arc-Flash Hazard Calculations--Amendment 1
14. IEEE 1584b: Guide for Performing Arc-Flash Hazard Calculations--Amendment 2: Changes to Clause 4

D. Underwriters' Laboratories
1. UL 1: Flexible Metal Conduits
2. UL 4: Armored Cable
3. UL 5: Surface Metal Raceways and Fittings
4. UL 5A: Nonmetallic Surface Raceways and Fittings
5. UL 5B: Standard for Strut-Type Channel Raceways and Fittings
6. UL 5C: Standard for Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits
7. UL 6: Electrical Rigid Metal Conduit – Steel
8. UL 13: Power Limited Circuit Cables
9. UL 44: Thermoset-Insulated Wires and Cables
10. UL 83: Thermoplastic Insulated Wires and Cables
11. UL 310: Electrical Quick-connect Terminals
12. UL 360: Liquid Tight Flexible Steel Conduit
13. UL 444: Communications Cables
14. UL 467: Grounding and Bonding Equipment
15. UL 486A: Wire Connectors
16. UL 486B: Wire Connectors
17. UL 486C: Splicing Wire Connectors
18. UL 486D: Sealed Wire Connector Systems
19. UL 493: Thermoplastic Insulated Underground Feeder and Branch Circuit Cables
20. UL 510: Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
21. UL 514A: Metallic Outlet Boxes
22. UL 514B: Conduit, Tubing, and Cable Fittings
23. UL 514C: Nonmetallic Outlet Boxes, Flush-device Boxes, and Covers
24. UL 514D: Cover Plates for Flush-mounted Wiring Devices
25. UL 635: Insulating Bushings
26. UL 651: Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
27. UL 797: Electrical Metallic Tubing – Steel
28. UL 870: Wireways, Auxiliary Gutters, and Associated Fittings
29. UL 969: Marking and Labeling Systems
30. UL 1242: Standard for Electrical Intermediate Metal Conduit - Steel
31. UL 1332: Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment
32. UL 1446: Systems of Insulating Materials – General
33. UL 1479: Fire Tests of Through Penetration Firestops
34. UL 1565: Position Devices (includes cable ties and clamps)
35. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
36. UL 1652: Flexible Metallic Tubing
37. UL 1685: Vertical-tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables
38. UL 1773: Standard for Termination Boxes
39. UL 1977: Component Connectors for Use in Data, Signal, Control, and Power Applications
40. UL 2024: Standard for Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies
41. UL 2196: Test for Fire Resistive Cables
42. UL 2239: Hardware for the Support of Conduit, Tubing, and Cable

43. UL 2250: Standard for Instrumentation Tray Cable
44. UL 2256: Nonmetallic Sheathed Cable Interconnects
45. UL 2257: Identification Tests for Jacket and Insulation Materials Used in Plenum Cables
46. UL 2556: Wire and Cable Test Methods

1.4 QUALITY ASSURANCE

A. Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B. Supply equipment and accessories new, free from defects.
C. Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state, and local codes.
D. Items of a given type shall be the products of the same manufacturer.
E. Deliver, store, and protect products under provisions of Section 016000.
F. Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
G. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
H. Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITTALS

A. Submit under provisions of Section 013000 or 013300.
B. Submittals shall include the following:
    1. Table of contents
    2. A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
    3. Part numbers
    4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
    5. Maintenance instructions and intervals
    6. Calibration procedures and intervals
    7. A complete set of drawings for any special items
    8. Wiring diagrams
C. Electronic submittals shall be searchable.
D. Seismic Restraint and Anchorage: Provide complete seismic anchorage and bracing for the lateral and vertical support of conduit and electrical equipment in accordance with CBC, Title 24, Part 2, Section 1616A.1 and ASCE 7-10 Section 13.6, and all provisions of this Section.
    1. Submit calculations prepared and signed by a Structural Engineer licensed in the State of California, showing compliance with the above for all electrical equipment weighing more than 50 pounds, excepting items corresponding exactly in configuration and weight to those specified and detailed. Where anchorage details are not shown on drawings, the field installation shall be subject to the approval of the Electrical Engineer.
    2. All equipment mounted on concrete shall be secured with post-installed concrete requiring a drilled hole. Power driven anchors are not acceptable. Minimum spacing shall be 10 times the diameter center to center and 5 diameters center to edge of concrete. Maximum allowable loads for tension and shear shall be as determined in compliance with ACI 318-14 Chapter 17 and the anchor’s ICC or IAPMO evaluation report. Acceptable manufacturers are Hilti, Red Head, and Simpson Strong Tie.

3. Conduit and suspended equipment shall be provided with supports and seismic restraints in accordance with Unistrut, Inc. Seismic Bracing Guide, or Super Strut Inc., Seismic Restraint System guide. Support requirements shall e based upon similar equipment, i.e., water piping as equivalent to conduit with wire fill. A copy of the guide shall be on the job site during construction.

E. The submittal shall be substantially complete for all items and equipment furnished under this section.

F. Individual drawings and data sheets submitted at random intervals will not be accepted for review.

G. Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Submit operation and maintenance manuals in accordance with Section 260000.

B. The manuals shall, at minimum, include the following:
1. Table of contents
2. Manufacturer (including contact information)
3. Model number
4. Voltage ratings
5. Current ratings
6. List of capabilities
7. Environmental ratings
8. NEMA enclosure type
9. Maintenance instructions and intervals
10. Calibration procedures and intervals
11. Installation instructions
12. Repair instructions (where applicable)
13. As-built drawings

C. Provide manuals in one of the following formats.
1. Three hardcopies
2. PDF

PART 2 – PRODUCTS

2.1 CONDUIT AND OTHER RACEWAYS

A. Rigid Conduit, also referred to as Galvanized Rigid Steel Conduit (GRS)
1. Material: High strength steel
2. Coating
a. All uses: hot-dipped galvanized
b. Underground or corrosive areas
1. 40-mil, UV stabilized PVC coated
2. Coating shall conform to NEMA RN-1
3. Fittings shall be threaded.
4. Conduit shall be UL-6 listed.

B. Intermediate Metal Conduit (IMC)
1. Material: Steel
2. Coating
a. All uses: hot-dipped galvanized
b. Underground or corrosive areas
1. 40-mil, UV stabilized PVC coated
2. Coating shall conform to NEMA RN-1
3. Conduit shall be UL-1242 listed.

C. Electrical Metallic Tubing (EMT)

1. Material: Steel
2. Coating
    a. All uses: hot-dipped galvanized
    b. Underground or corrosive areas
        1. 40-mil, UV stabilized PVC coated
        2. Coating shall conform to NEMA RN-1
3. Fittings shall be threaded.
4. Connectors and couplings
    a. Watertight, steel compression type exterior and in wet locations. Use ETP Fittings InspectoRidge or approved equal when possible.
    b. Steel set screw type in interior, dry locations.

D. Non-metallic conduit
1. Conduit shall be schedule 40 PVC (minimum)
2. Approved for use as non-metallic raceway with 90°C conductors
3. Comply with NEMA TC-2 and NEMA TC-3

E. Flexible Metallic Conduit
1. Material: High strength, hot-dipped galvanized steel
2. Construction: Interlocked
3. Conduits in damp, wet, or corrosive areas shall be liquid tight type with PVC jacket extruded over the steel conduit.

F. Fittings and accessories
1. Fittings and accessories for all conduit types shall be approved for the purpose and equal in all respects to the conduit or raceway.
2. Fittings and accessories for metallic conduits shall be made of ferrous metal and galvanized after fabrication.

G. Pull lines
1. Pull line shall be 1/8” diameter, yellow color.
2. Pull lines shall be Tubbs Cordage "Polyline" or approved equal.

H. Wireways
1. NEMA type
    a. NEMA-1 for dry locations
    b. NEMA-3R or NEMA-4 for damp and wet locations
    c. NEMA-4X for corrosive locations
2. Metal type
    a. Non-corrosive locations: mild steel
    b. Corrosive locations: stainless steel
3. Thicknesses
    a. 6”x6” cross-section and smaller: 16 gauge
    b. 8”x8” cross-section and larger: 14 gauge
4. Finish: The entire enclosure shall be finished as follows:
    a. Degreasing
    b. Cleaning
    c. Phosphatizing
    d. Electrostatic deposition of polymer polyester powder coating followed by baking to produce a hard, durable finish.
        1. The average thickness of the paint film shall be 2.0 mils.
        2. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.
    e. Finish shall conform to UL 50 and UL 50E.
    f. Color shall match surrounding area.
5. Covers
    a. Wireways shall have hinged covers.
    b. NEMA 3R, 4 and 4X wireways shall be a gasket on the inside of the cover to seal the wireway when cover is closed.
    c. Covers shall have latches to secure the cover in the closed position.
6. Wireways shall be UL listed.

I. Cable Trays
   1. Material: High strength steel
   2. Coating
      a. All uses: hot-dipped galvanized
      b. Underground or corrosive areas: 40-mil, UV stabilized PVC coated, coating shall conform to NEMA RN-1
   3. Construction
      a. Trays shall be ladder type unless otherwise noted.
      b. Maximum distance between cross-members shall be 12 inches.
   4. Trays shall meet NEMA VE-1 standards.

J. Raceways shall be UL listed.

2.2 WIRE AND CABLE

A. Conductors for power and lighting systems 600V or less:
   1. Conductors shall be 90°C rated.
   2. Conductors size #12 AWG and larger shall be stranded copper.
   3. Type:
      a. THWN-2 for wet or underground locations
      b. THHN for dry locations.
      c. 90°C rated
   4. Minimum conductor size for voltage drop:
      a. Minimum size shall be per CEC Tables 310.15(B)(16), 310.15(B)(2)(a), and 310.15(B)(2)(b) for runs 50 feet or less for 208/120V systems or 100 feet or less for 480/277V systems
      b. Increase conductor size by one method below:
         1. One size for each additional 50 feet for 208/120V systems or 100 feet for 480/277V systems.
         2. Calculate voltage drop and size as directed by CEC Voltage Drop Restrictions.
      c. Underground circuits shall be #8 AWG minimum wire, unless otherwise noted.
      d. Once the contractor has determined conductors' route, calculate the minimum size to meet maximum voltage drop allowed per CEC using $D_{min}=C*P*L*I/(V_D*N)$.
         1. D_{min} is the minimum diameter (circular mills)
         2. C=12 for copper, C=19.5 for aluminum
         3. P=2 for single phase, P=$\sqrt{3}$ for three-phase
         4. L is conductor length (feet)
         5. I is the current (amps)
         6. V_D is the maximum allowable voltage drop (volts)
         7. N is the quantity of parallel conductors per phase
   5. Minimum size conductors for OCPD shall be determined from CEC Table 310.16 with ampacity corrected for 115°F. Derate ampacity for more than three current carrying conductors per the CEC.
   6. Conductor size shall be the largest size to meet maximum voltage drop (2.2 A 4) and to meet CEC ampacity requirements (2.2 A 5).

B. For Signal and Communication Circuits:
   1. Special Cables: As specified on Drawings.
   2. Conductors for general communications use: Stranded copper conductor, #16 AWG minimum, with THWN insulation for underground or wet locations and THHN insulation for dry locations.
   3. Ends of stranded conductors shall be tinned.

2.3 OUTLET BOXES, JUNCTION BOXES, AND PULL BOXES

A. Above ground locations
   1. Outlet Boxes
      a. Hot-dipped galvanized after fabrication
      b. Of required size, minimum 4 inches square, for flush mounted devices and lighting fixtures
      c. Cast type with gasketed covers for outdoor or wet locations.
      d. Device and fixture back boxes shall be 2-1/4" deep, minimum.
   2. Junction and Pull Boxes
      a. Use outlet boxes with appropriate covers as junction boxes wherever possible.
      b. Larger junction and pull boxes
         1. Sheet steel, hot dipped galvanized after fabrication, finished gray baked enamel
         2. Sized according to code
         3. Screw-on covers.

B. In-ground pull boxes, handholes, and manholes
   1. Precast concrete type with required extension collars.
   2. Covers
      a. Lids shall be steel or reinforced concrete, as shown on plans. Pull box lids in traffic areas or large grassy areas subject to mowing by riding mowers shall traffic rated.
      b. Covers shall include hold down bolts.
      c. Top of cover shall be flush with top of box.
      d. Covers shall be identified as ELECTRICAL, SIGNAL, or COMMUNICATIONS unless otherwise specified.
   3. Size boxes as indicated on Drawings. If size is not indicated on Drawings, use CEC as a minimum requirement.
   4. Boxes shall have 2" thick (minimum), reinforced concrete bottoms with 1" diameter drain hole over 12" of crushed rock.
   5. Boxes shall have approved cable supports.
   6. Concrete encased stubs for handholes extending five (5) feet beyond handhole.
   7. All pull boxes shall be no smaller than a Christy N-9.
   8. All pull boxes shall be set flush to finished grade and shall have an 8" wide by 3" thick concrete mow strip poured around it.
   9. Manufacturer shall be Brooks Products, Oldcastle Enclosure Solutions (Christy), Jensen Precast, or approved equal.
   10. All sections between box, extension rings, etc. and penetrations shall be sealed with mortar.

C. Floor Boxes
   1. Provide Walker or equal Modulink non-metallic floor box for concrete areas.
   2. Provide quantity of boxes required to accommodate each device.
   3. Provide Walker Wood Floor Boxes at wood floors provide quantity required to accommodate each device.
   4. Provide brass flip cover lids.

D. Outlet boxes, junction boxes, pull boxes, etc. recessed in a concrete wall shall be deep masonry boxes.

2.4 CONDUIT AND EQUIPMENT SUPPORTS

A. Conduit supports
   1. For Individual conduit runs not directly fastened to the structure: Rod hangers
   2. For multiple conduit runs: Trapeze type conduit support designed for maximum loading deflection not exceeding manufacturer's recommendations.

B. Materials

1. All materials not otherwise noted:
    a. Steel with the finished part hot dipped galvanized
    b. Stainless steel for corrosive or damp environments
2. All bolts and nuts shall be stainless steel.

C. Supports anchored to earth shall be anchored in a concrete base per details.
D. Manufacturers shall be Caddy, Unistrut, Powerstrut, or approved equal.
E. All exposed channels shall have end caps made by the channel manufacturer and designed for use with the channel.

2.5 WIRE CONNECTORS

A. For wire size #8 AWG and smaller: Insulated, screw type, rated 105°C, 600V for building wiring and 1000V for fixtures; Scotchlok, Ideal, or approved equal.
B. For wire size #6 AWG and larger: T&B or approved equal screw type with 3M "#33+" or Plymouth "Slipknot Gray" tape insulation.
C. Underground wire splices
    1. Connect ends of conductors with copper compression connectors, 3M Scotchlok or approved equal.
    2. Seal splice with inline resin splice kit approved for weather exposure, direct burial, and wet locations, 3M Scotchcast or approved equal.
D. Only set screw, compression type connectors may be used for MC cables. Fishhook/open tang connectors are prohibited.

2.6 GROUNDING

A. Ground Rods
    1. 3/4" diameter
    2. Copper weld type
    3. 10’-0” in length
B. Ground Wire: Conductors shall be medium-hard drawn, copper, and stranded, with sizes as shown on drawings.
C. Utilize CADWELD Multi-System Exothermic Welding for below grade ground connections.
D. Bolts, nuts, and washers shall be bronze, cadmium plated steel, or other corrosion resistant material approved for the purpose.

2.7 MISCELLANEOUS MATERIALS

All screws, bolts, nuts, and washers on equipment outdoors or in wet or corrosive environments shall be stainless steel.

2.8 SEALANTS

A. General purpose sealant: One part polysulfide or polyurethane, Federal Standard TT-S-00230c or two-part polyurethane, Federal Standard TT-SS-227E of Mameco Vulkem 116 or 227 or approved equal product manufactured by Products Research and Chemical Corporation. Pecora, Sika, Sonneborn, or Tremco may be substituted under provisions of Section 016000.
B. Conduit sealant
    1. Two part, self curing urethane
    2. Non-sagging
    3. Liquid and gas tight
    4. Chemically stable once cured
    5. Compatible with conduit and conductor materials
    6. Designed for use as conduit seal

C. Fire retardant sealant: Dow Corning Company, Type 3-6548 silicone RTV foam sealant, closed cell, 18 lb. density, 2-part system with UL certification. Type 96-081 one-part sealant shall be used for small spaces and cracks. 3M Fire Barrier Caulk CP25 is also acceptable.

2.9 IDENTIFICATION

A. Nameplates:
   1. White, acrylic plastic suitable for indoor or outdoor use
   2. Face colored as below with engraved, white, 3/16" minimum, Arial or similar font characters
      a. Equipment on normal systems: Black face
      b. Equipment on emergency systems: Red face
   3. Clear plastic overlay suitable for indoor or outdoor use that can be replaced if vandalized.
   4. Sign shall include device name, voltage, and size.
   5. Outdoor nameplates shall be UV stable and fade resistant.

B. Pull line identification tags:
   1. Aluminum plate
   2. 1/8" tall (minimum), Arial (or similar) font, identifying text stamped on plate
   3. Tags shall describe conduit's length, source, and destination.

PART 3 – EXECUTION

3.1 GENERAL

A. Electric system layouts indicated on the Drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of cable and wiring and the locations of outlets by the structure and equipment served. Dimensions shall be taken from Architectural Drawings.

B. Consult all other Drawings. Verify scales and report any dimensional discrepancies or other conflicts to architect, or engineer if no architect is involved, before submitting bid.

C. Home runs to panelboards are indicated as starting from the outlet nearest the panel and continuing in the general direction of that panel. Continue such circuits to the panel as though the routes were completely indicated. Terminate homeruns of signal, alarm, and communications system in a similar manner.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect and conform to structural requirements when cutting or boring the structure is necessary or permitted.

E. Furnish and install necessary hardware, hangers, blocking, brackets, bracing, runners, required for equipment specified under this section.

F. Provide necessary backing required to insure rigid mounting of outlet boxes.

G. Install pull line in all conduits to remain that will have their conductors removed.

3.2 INSTALLATION OF CONDUIT

A. Run conduit concealed unless otherwise noted or shown on Drawings.

B. Run exposed conduit parallel to or at right angles to center lines of columns and beams.

C. Run no conduit in concrete slabs or floors except at point of penetration. Penetrations shall be at right angles to slab surfaces.

D. Install conduit above ceilings to avoid obstructing removal of ceiling tiles, lighting fixtures, air diffusers, etc.

E. Conduit shall not cross any duct shaft or area designated as future duct shaft. Coordinated with mechanical work to avoid any conflict.

F. Install pull line in empty conduit installed under this contract. Provide and install labels as describe in “Identification” sub-section.

G. Spare conduits shall be capped to prevent intrusion of moisture and foreign objects.

H. Minimum conduit size shall be 1/2" when installed above ground and 3/4" when installed underground or under building slabs. Increase conduit size as required for wiring. Size for conduit, unless specifically shown otherwise, shall be determined from Table 3 for all conductors, Chapter 9 of latest National Electric Code.

I. Conduit shall be rigid conduit, IMC, EMT, or plastic as follows, unless otherwise noted on plans:
   1. Above ground and dry locations: Use rigid conduit, IMC or EMT.
      a. Wet locations: Rigid conduit, IMC.
      b. Locations subject to mechanical injury: Rigid conduit or IMC only.
      c. In concrete walls or block walls: Rigid steel conduit or IMC only.
      d. Dry locations and not subject to mechanical injury: EMT (interior locations only), IMC, or rigid conduit.
   2. Underground: Use wrapped rigid steel or plastic.
      a. Schedule 40 PVC: For use underground where protected by concrete slabs, asphaltic pavement, or concrete walkways. Use steel elbows for plastic conduit runs penetrating floor slabs. Bends in plastic conduit other than normal long sweeps shall be made only with factory formed ells or curved segments. Heat bending may not be used. Sections of rigid steel conduit runs are required where direction changes. In all cases where use of plastic conduit is allowed or specified, Contractor may, at his option, use rigid steel conduit.
      b. Underground conduits shall have red 4” wide identifying caution tape reading "CAUTION ELECTRICAL LINE BELOW”, length as required and installed 12” above all conduits runs.
      c. Do not install plastic conduit in rock base.
      d. Underground conduit entering building shall be provided with one (1) 10-foot section of rigid steel conduit at point of penetration of foundation, footing or basement wall, with approximately equal lengths inside and outside building line, unless otherwise noted.
   3. Bends
      a. Make risers to grade with rigid steel long radius sweep conduit and rigid steel elbow fittings only.
      b. Conduit shall enter pull boxes at 45-degress.

J. Burial depth of conduit shall be as follows:
   1. Concrete encased: 24” minimum for 600V or lower systems to top of concrete encasement.
   2. Conduit without concrete encasement or cap: 24” minimum to top of conduit.
   3. When installed under buildings, the above minimum depth shall be 18” below bottom of floor slab.

K. Use flexible steel conduit in the following applications:
   1. Recessed lighting fixtures.
   2. Motor connections.
   3. Connection between fan plenum and structure.
   4. At expansion joints.
   5. At transformers and other equipment which produce vibration.

L. Provide junction boxes/pull boxes as required to limit any power system conduit run to a maximum of four (4) 90° bends (two (2) 90° bends for signal communication system conduit runs) or to avoid "U" bends.

M. Conduit Supports:
   1. Support conduit with Underwriters' Laboratories listed conduit support intervals required by the California Electric Code.
   2. Wire or sheet metal strips are not acceptable for conduit not directly fastened to structure or for multiple conduit runs.

3. Individual conduit 1/2" and 3/4" size may be supported from ceiling support wire with Caddy clips only if acceptable to local code. Only one conduit is permitted to be attached to any ceiling support wire. Hang such conduit so as not to affect level of ceiling.
4. Avoid attaching conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between the section attached to the fan plenum and other sections. Provide a length of flexible conduit between the portion attached to the building to minimize transmission of vibration to the building structure.

N. Conduit penetration of roof, walls, floors, and ceilings shall be sealed to preserve the integrity of waterproofing, fire rating and soundproofing for which the roof, wall, floor, or ceiling is designed. Materials and methods used shall conform to that specified under Architectural sections.
O. Underground conduit and ducts 2” and larger shall be proven clear by pulling through a mandrel 1/4" smaller than the inside diameter.
P. Where flush branch circuit panelboards or terminal cabinets are shown on walls, stub a minimum of four (4) 1” empty conduit into overhead ceiling spaces and four (4) 1” empty conduit into space below floor (if any) in addition to conduit required for circuit wiring.
Q. Paint all exposed conduit to match its surroundings.
R. Plastic conduits exposed to sun light shall be UV stabilized.
S. Where rigid steel conduit runs in direct contact with the earth, conduit shall have factory applied PVC coating.
T. Label all conduits at each terminus, pull box, and junction box.
U. All conduits shall have a minimum of one pull line.
V. All pull lines shall be tagged at both ends to indicate the length of the conduit run, source, and the destination.

3.3 INSTALLATION OF WIRE

A. Install all wiring in raceway unless specifically shown or noted otherwise.
B. Pull no wire into any portion of the conduit system until construction work which may damage the wire has been completed.
C. Install wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in handholes, pull boxes or junction boxes. Make branch circuit splices in outlet boxes with 8 inches of correctly color-coded tails left in the box.
D. Make splices in wires and cables utilizing specified materials and methods.
E. Cables and wires passing through handholes shall be full looped inside the handhole (360°) and supported on galvanized steel racks, beginning 10” above the bottom of the handhole. Leave handhole in clean condition with debris removed.
F. Make ground, neutral, and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to ground terminal of devices when the device is not approved for grounding through the mounting screws.
G. Provide Brady wire markers where number of conductors in a box exceed four (4).
H. Wiring shall be tested for continuity (600V and below). All systems shall be entirely free from grounds, short circuits, and any or all defects.
I. Measure and record the insulation resistance of 600V insulated conductors size #4/0 AWG and larger using a 500 volt megger for one minute. Make tests with circuits isolated from source and load.
J. All conductor bends must have a radius greater than or equal to the manufacturer’s listed bending radius.
K. Label all conductors at each terminus, pull box, and junction box.

3.4 WIRE COLOR CODE

A. Color code conductors. Wire sized #8 AWG and smaller shall have integral color coded insulation. Wire sizes #6 AWG and larger may have black insulation but shall be identified by color coded electrical tape at junction, splice, pull and termination points. Apply color tape with 1/2 width overlap to at least 6" of the conductor.

B. Color code wire as follows:

Conductors	208/120V	480/277V
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White or Gray (consistent throughout facility)
Ground	Green	Green

3.5 CONNECTIONS TO EQUIPMENT

A. General:
1. Furnish and install required power supply conduit and wiring to equipment. See below for other wiring required.
2. Furnish and install a disconnect switch immediately ahead of and adjacent to each magnetic motor starter or appliance unless the motor or appliance is located adjacent to and within sight of the serving panelboard, circuit breaker or switch. Verify equipment nameplate current ratings prior to installation.
3. Mount motor starters including those furnished under other sections or specifications and provide power wiring to them.
4. Install rough-in work for equipment from approved shop drawings to suit the specific requirements of the equipment.
5. Furnish and install magnetic motor starters that are shown on the Drawings or specified under other divisions to be furnished under this division of work. Verify equipment nameplate ratings prior to installation and furnish adequately rated starters for the loads.
6. Furnish and install manual thermal protection for motors not integrally equipped with thermal protection.
7. Furnish and install 120V power to each control panel and time switch requiring a source of power to operate.

B. Heating, ventilating, and air conditioning equipment:
1. Coordinate with mechanical contractor for sizes, locations and details of motors, heating units, and control requirements.
2. Provide required power supply conduit and wiring to equipment.
3. Provide a suitable means of disconnect switch immediately ahead of and adjacent to each motor and appliance unless the motor or appliance is located adjacent and within sight of the service panelboard, circuit breaker or switch at a distance allowed by codes. Verify equipment nameplate current ratings prior to installation. Provide a disconnect means at each magnetic motor starter.
4. Provide magnetic motor starters required under this division of work.
5. Provide manual thermal protection for motors not integrally equipped with thermal protection.
6. Line and low voltage temperature control and interlock wiring, conduit, and required connections are a part of other divisions unless specifically shown or noted on the Drawings as to be furnished under this section.
7. Provide 120V power supply to control panels, time switch furnished and installed under other divisions of work.
8. Furnish and install 120V power to each duct detector scheduled for operation of fire dampers or shut down of mechanical equipment. Coordinate the exact quantity and locations with the mechanical drawings.

C. Plumbing and other contractor-furnished and Owner-furnished equipment:

1. Required power and control conduit, wiring and connections are included under this section of the work. Control sensing and alarm devices will be furnished under the respective section of the contract supplying the equipment unless noted otherwise. These devices will be in pipes, ducts, vessels, tanks, etc., and will be mounted in a place by the Contractor furnishing the devices. Other devices shall be mounted under this section of the work.
2. Control panels for packaged equipment will be furnished under the respective section of the contract supplying the equipment unless otherwise noted. Installation and connection of the control panels are under this section of the work.

3.6 SYSTEM NEUTRAL GROUND

A. Ground the neutral conductor of each transformer to limit the maximum potential above ground due to normal operating voltage and limit the voltage level due to abnormal conditions.
B. Ground transformers with secondary voltage 600V class or less as follows: 3 phase, 4 wire wye connected: ground neutral point.
C. For transformers 75kVA size or lower with primary voltage 480V or lower, the primary equipment ground conductor may be used for grounding the secondary neutral provided it is adequately sized in accordance with CEC system ground conductor size.

3.7 EQUIPMENT GROUND

A. Ground non-current carrying metal parts of electrical equipment enclosures, frames, or conductor raceways to provide a low impedance path for line to ground fault current and to bond all non-current carrying metal parts together. Install a ground conductor in each raceway system. Equipment ground conductor shall be electrically and mechanically continuous from the electrical circuit source to the equipment to be grounded. Size ground conductors per CEC 250.95 unless otherwise shown on drawings.
B. Grounding conductors shall be identified with green insulation. Where green insulation is not available, on larger sizes, black insulation shall be used and suitably identified with green tape at each junction box or enclosure device.
C. Install metal raceway couplings, fittings, and terminations secure and tight to ensure good ground continuity. Provide grounding bushing and bonding jumper where metal raceway is not directly attached to equipment metal enclosure and at concentric knockouts.
D. Lighting fixtures shall be securely connected to equipment ground conductors. Outdoor lighting standards shall have a factory installed ground for terminating the ground wire.
E. Motors shall be connected to equipment ground conductors with a conduit grounding bushing and with a bolted solderless lug connection on the metal frame.

3.8 STRUCTURAL GROUND

A. Concrete encased electrode shall be 2 inches above the bottom of concrete footing where shown on drawings. See drawings for details.
B. Domestic, chilled, and hot water mains and fire protection metallic water pipes shall be connected to the ground bus with #4/0 AWG bare copper conductor at a minimum of two points.
C. Miscellaneous metal objects including piping, vessels, and structural shapes within six feet of metallic objects connected to the ground system and which are not interconnected mechanically with the grounding system, shall be interconnected with a minimum #6 AWG bare copper conductor.

3.9 IDENTIFICATION

A. Provide and install nameplates on all switchboards, distribution boards, panels, motor starters, VFDs, transformers, safety switches/disconnects, push buttons, selector switches, pilot lights, and other similar devices. Fasten nameplates to equipment with one sheet metal screw at each corner.

B. Provide and install labels on lighting switches and convenience and special purpose receptacles to show panel and circuit number to which the device is connected.

C. Provide and install identification tags on all conduit pull ropes.

D. Provide label meeting ANSI Z535 standards on motors reading:

WARNING
AUTOMATIC EQUIPMENT
MAY START AT ANY TIME

3.10 CIRCUIT BREAKER ELECTRICAL COORDINATION STUDY

If required, contractor shall provide a coordination study to determine trip settings of circuit breakers. Provide an electric copy of the studies to the Electrical Engineer of Record in EasyPower.

3.11 ARC FLASH STUDY

If required, contractor shall provide a study to determine potential arc flash energy. Provide an electric copy of the studies to the Electrical Engineer of Record in EasyPower.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Hangers and supports for electrical equipment and systems.
B. Construction requirements for concrete bases.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A All included sections under Division 1
B All included sections under Division 26
C All included sections under Division 27
D Plans
E Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.
B American Society for Testing and Materials (ASTM)
  1 ASTM A36/A36M: Standard Specification for Carbon Structural Steel
  2 ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  3 ASTM A276: Standard Specification for Stainless Steel Bars and Shapes
  4 ASTM A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength
  5 ASTM A563: Standard Specification for Carbon and Alloy Steel Nuts
  6 ASTM B221: Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
  7 ASTM B632: Standard Specification for Aluminum-Alloy Rolled Tread Plate
  8 ASTM B633: Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  9 ASTM E488: Standard Test Methods for Strength of Anchors in Concrete Elements
  10 ASTM F594: Standard Specification for Stainless Steel Nuts
C American Welding Society (AWS)
  1 AWS D1.1: Structural Welding Code - Steel
D California Building Safety Codes (CBSC)
  1 California Building Code (CBC)
  2 California Electrical Code (CEC)
E General Services Administration
  1 FF-S-325
  2 W-C-582: Conduit, Raceway, Metal and Fittings: Surface
  3 WW-H-171: Hanger and Support, Pipe
F Manufacturers Standardization Society (MSS)
  1 MSS SP-58: Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
  2 MSS SP-69: Pipe Hangers and Supports – Selection and Application
G National Electrical Contractors Association
  1 NECA 1: Standard Practice of Good Workmanship in Electrical Construction
  2 NECA 101: Standard for Installing Steel Conduits (Rigid, IMC, EMT)
H Underwriters' Laboratories
  1 UL 2239: Hardware for the Support of Conduit, Tubing, and Cable

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with latest editions of the California Building Code and California Electric Code

1.5 SUBMITTALS

A. Submit under provisions of Section 013000 or 013300.
B. Submittals shall include the following:
    1. Table of contents
    2. A complete set of detailed manufacturer's specifications describing and illustrating all standard and special components and materials
    3. Part numbers
    4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
    5. Maintenance instructions and intervals
    6. A complete set of drawings for any special items
C. Electronic submittals shall be searchable
D. Shop drawings shall be stamped and signed by a licensed structural engineer. Show fabrication and installation details and include calculations for the following:
    1. Trapeze hangers: include product data for components
    2. Steel slotted channel systems: include product data for components
    3. Equipment supports
E. Welding certificates
F. The submittal shall be substantially complete for all items and equipment furnished under this section.
G. Individual drawings and data sheets submitted at random intervals will not be accepted for review.
H. Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit manuals at close out.
B The manuals shall, at minimum, include the following:
    1 Manufacturer (including contact information)
    2 Model number
    3 Load ratings
    4 Material type(s)
    5 Environmental ratings
    6 Maintenance requirements
    7 Installation instructions
    8 Repair instructions (where applicable)
C Provide manuals in one of the following formats
    1 Three hardcopies
    2 PDF

1.7 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

PART 2 – PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems
   1. Comply with MFMA-4, factory-fabricated components for field assembly.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Nonmetallic Coatings:
      a. PVC, polyurethane, or polyester coating applied according to MFMA-4.
      b. Minimum thickness shall be 40 mils.
   4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.
   6. Manufacturers:
      a. Cooper B-Line, Inc.
      b. ERICO International Corporation
      c. Hilti Corporation
      d. Thomas & Betts Corporation
      e. Unistrut
      f. Approved equal

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components:
   1. General:
      a. Anchors shall be steel with corrosion resistant, durable coating or stainless steel
      b. Select anchors with strength required for anchor and as tested according to ASTM E488.
      c. Minimum length shall be eight times diameter.
      d. Tension, shear, and pullout capacities shall be appropriate for supported loads and building materials used
      e. Post installed anchors must be listed in a current evaluation report issued by one of the following:
         1. International Code Council Evaluation Service (ICC-ES) (http://www.icc-es.org/reports/index.cfm?search=search)
         2. City of Los Angeles Research Report
   2. Powder-Actuated Fasteners:
      a. Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood
      b. Manufacturers:

1. Hilti Corporation
2. Simpson Strong-Tie Co., Inc.
3. Approved equal

3. Mechanical-Expansion Anchors:
   a. Insert-wedge-type, stainless steel, for use in hardened portland cement
   b. Anchors shall meet the descriptive part of Federal Specifications FF-S-325 Group II, Type 2, Class 2, Style 1.
   c. Anchors shall be equivalent to Hilti Kwik-Bolt TZ.
4. Concrete inserts shall be steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58
5. Clamps for attachment to steel structural elements: MSS SP-58, type suitable for attached structural element
6. Through bolts shall be structural type, hex head, high strength and comply with ASTM A325
7. Toggle Bolts: All-steel springhead type
8. Hanger Rods: Threaded steel

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials:
   1. Comply with requirements with ASTM A36 (ferrous metals), ASTM A167 and ASTM A276 (stainless steel), and ASTM B221 and B632 (aluminum) for shapes and plates.
   2. Hot dipped galvanized steel
   3. Stainless steel for corrosive areas

PART 3 – EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by California Electrical Code. Minimum rod size shall be 1/4" diameter.

C. Multiple Raceways or Cables:
   1. Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25% in future without exceeding specified design load limits.
   2. Secure raceways and cables to these supports with two-bolt conduit clamps

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2” and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in California Electric Code.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading

limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 pounds.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code.
   1. Wood framing: Fasten with lag screws or through bolts.
   2. Light gauge steel framing: self tapping screws
   3. Steel beams: beam clamps
   4. Concrete: expansion fasteners

3.3 CONDUIT SUPPORTS

A Conduit supports
   1 For Individual conduit runs not directly fastened to the structure: Rod hangers
   2 For multiple conduit runs: Trapeze type conduit support designed for maximum loading deflection not exceeding manufacturer's recommendations.
   3 Wire or sheet metal strips are not acceptable for conduit not directly fastened to structure or for multiple conduit runs.

B Support conduit with Underwriters' Laboratories listed conduit support intervals required by the California Electric Code.

C Individual conduit 1/2" and 3/4" size may be supported from ceiling support wire with Caddy clips only if acceptable to local code. Only one conduit is permitted to be attached to any ceiling support wire. Hang such conduit so as not to affect level of ceiling.

D Avoid attaching conduit to fan plenums. When it is necessary to support conduit from fan plenum, provide a length of flexible conduit between the section attached to the fan plenum and other sections. Provide a length of flexible conduit between the portion attached to the building and the rest of the conduit run to minimize transmission of vibration to the building structure.

E Supports anchored to earth shall be anchored in a concrete base per details.

3.4 INSTALLATION OF POST-INSTALLED ANCHORS

A. Minimum distances
   1. Bolt hole edge to edge of concrete: 10 times bolt diameter
   2. Bolt center to bolt center: 12 times bolt diameter

B. Expansion type anchors
   1. Anchor shall be installed and torque per manufacturer’s recommendations.
   2. Setting verification:
      a. Torque-controlled anchors: Following attainment of 10% of the required torque, torque-controlled anchors shall not require more than six additional complete turns of the nut during installation to achieve the manufacturer's specified installation torque. The extent of bolt projection after installation shall be measured to confirm that this requirement has been met.
      b. Displacement-controlled anchors: The position of the plug in the anchor shell shall be checked with the manufacturer-supplied installation tool or other appropriate device. The position of the plug shall conform to the manufacturer's specifications.
   3. Allowable loads
      a. Anchors not installed in underside of beam/slab:
         1. When tested in accordance with AC01, Section 5.6: Values listed in ICC-ES report
         2. When not tested in accordance with AC01, Section 5.6: 80% of values listed in ICC-ES report
      b. Anchors installed in underside of beam/slab:

1. When tested in accordance with AC01, Section 5.6: Values for anchor without special inspection or in cracked concrete in ICC-ES report
2. When not tested in accordance with AC01, Section 5.6: 80% of values for anchor without special inspection or in cracked concrete in ICC-ES report

C. Epoxy-type (adhesive) Anchors
1. Allowable loads: values from ICC-ES report when compliant with AC58.

D. Anchors must receive special inspection per CBC Sections 1704.3.8, 1705A.3.8, and 1910A.5 as applicable to the project.

3.5 TESTING AND INSPECTION OF POST-INSTALLED ANCHORS

A. General
1. Post-installed anchors shall be tested in accordance with the provisions of CBC Sections 1704.3.8, 1705A.3.8, and 1910A.5 as applicable to the project by an authority having jurisdiction accepted testing facility, unless approval of an alternative individual is obtained in advance from the authority having jurisdiction.
2. If any anchor fails testing, test all anchors of the same type, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency. If the anchors are used for the support and bracing of non-structural components (pipe, duct or conduit), the twenty (20) shall be only those anchors installed by the same trade.
3. Test equipment (including torque wrenches) is to be calibrated by an approved testing laboratory in accordance with standard recognized procedures.
4. Regardless of which test method is chosen, test values and all appropriate criteria shall be shown on the contract documents.
5. Anchor diameter refers to the thread size for the wedge and sleeve categories, and to the anchor outside diameter for the sleeve category.
6. Apply proof test loads to wedge and sleeve anchors without removing the nut if possible. If not, remove nut and install a threaded coupler to the same tightness as the original nut using a torque wrench to apply the test load.
7. For sleeve/shell internally threaded categories, verify that the anchor is not prevented from withdrawing by a baseplate or other fixtures. If restraint is found, loosen and shim or remove fixture(s) prior to testing.
8. Reaction loads from test fixtures may be applied close to the anchor being tested, provided the anchor is not restrained from withdrawing by the fixture(s).
9. Alternate torque test procedures and test values for shell type anchors may be submitted to the enforcement agency for review and approval on a case-by-case basis when test procedures are submitted and approved by the enforcement agency.
10. Required test loads may be determined by either of the following methods:
    a. Twice the allowable tension load from Part 3.4.
    b. Tension or torque test values from the table and procedures.

Test Values (Hardrock or Lightweight Concrete)							
Anchor	**Wedge**		**Sleeve**		**Shell**		**Screw**
Diameter (in)	Load (lbs)	Torque (ft. lbs)	Load (lbs)	Torque (ft. lbs)	Load (lbs)	Torque (ft. lbs)	Torque (ft. lbs)
1/4	800	10	400	4	1000	-	-
5/16	-	-	400	5	1400	-	-
3/8	1100	25	700	10	1800	-	10
1/2	2000	50	900	20	2700	-	10
5/8	2300	80	1100	45	3700	-	10
3/4	3700	150	1400	90	5400	-	20
1	5800	250	-	-	-	-	-

11. If the manufacturer's recommended installation torque is less than the test torque noted in the table, the manufacturer's recommended installation torque should be used in lieu of the tabulated values.

B. Expansion-type Anchors

1. The test load may be applied by any method that will effectively measure the tension in the anchor, such as direct pull with a hydraulic jack, calibrated spring loaded devices, or a calibrated torque wrench. Displacement-controlled anchors such as drop-ins shall not be tested using a torque wrench.
2. Anchors tested with a hydraulic jack should exhibit no discernable movement during the tension test, e.g., as evidenced by loosening of the washer under the nut.
3. Anchors tested with a calibrated torque wrench must attain the specified torque within 1/2 turn of the nut.
4. Exceptions: Undercut anchors that are so designed to allow visual confirmation of full set, need not be tension or torque tested. If the manufacturer's installation torque is less than the specified test torque, use the manufacturer's specified installation torque for testing the anchor.
5. Apply proof test loads to wedge and sleeve anchors without removing the nut if possible. If not, remove nut and install a threaded coupler to the same tightness as the original nut using a torque wrench to apply the test load.
6. For sleeve/shell internally threaded categories, verify that the anchor is not prevented from withdrawing by a baseplate or other fixtures. If restraint is found, loosen and shim or remove fixture(s) prior to testing.
7. Reaction loads from test fixtures may be applied close to the anchor being tested, provided the anchor is not restrained from withdrawing by the fixture(s).
8. Shell type anchors should be tested as follows:
   a. Visually inspect 25% for full expansion as evidenced by the location of the expansion plug in the anchor body. Plug location of a fully expanded anchor should be as recommended by the manufacturer, or, in the absence of such recommendation, as determined on the job site following the manufacturer's installation instructions. At least 5% of the anchors shall be proof loaded as indicated in the table above, but not less than three anchors per day for each different person or crew installing anchors, or;
   b. Test installed anchors per current edition of the CBC Sections 1704.3.8, 1705A.3.8, and 1910A.5 as applicable to the project.

C. Epoxy-type (adhesive) Anchors

1. Epoxy-type (adhesive) anchors shall be tension tested per current edition of the CBC Table 1705A.3. The tension test load shall equal twice the allowable load for the specific location of the anchor to be tested (i.e., accounting for edge distance) or 80% of the yield strength of the bolt ($0.8A_bF_y$), whichever is less. The test procedures for expansion-type anchors in the attached table shall also be used for

epoxy-type (adhesive) anchors. Torque testing of epoxy-type (adhesive) anchors is not permitted.

2. Where epoxy-type (adhesive) anchors are used as shear dowels across cold joints in slabs on grade and the slab is not part of the structural system, testing of those dowels is not required.
3. Anchors shall exhibit no discernible movement during the tension test.

D. Screw-type Anchors

E. The following criteria apply for the acceptance of installed anchors:
   1. Hydraulic ram method: The anchor should have no observable movement at the applicable test load. For wedge and sleeve type anchors, a practical way to determine observable movement is that the washer under the nut becomes loose.
   2. Torque wrench method: The applicable test torque must be reached within the following limits:
      a. Wedge or Sleeve type: One-half turn of the nut.
      b. One-quarter turn of the nut for the 3/8” sleeve anchor only.

3.6 PAINTING

A. Touchup:
   1. Clean field welds and abraded areas of shop paint.
   2. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
   3. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
   4. Comply with the following requirements
      a. Architectural painting specifications
      b. SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 263410

STATIC UNINTERRUPTIBLE POWER SUPPLIES – BATTERY

PART 1 – GENERAL

1.1 SECTION INCLUDES

This specification includes requirements for on-line, double conversion, solid state uninterruptable power supply (UPS) with battery energy storage.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A All included sections under Division 1
B All included sections under Division 26
C All included sections under Division 27
D Plans
E Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A Federal Communications Commission Part 15, Subpart J, Class A
B California Building Standards Codes
  1 California Building Code
  2 California Electrical Code
C Institute of Electrical and Electronic Engineers (IEEE)
  1 IEEE 450: Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications
  2 IEEE 484: Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
  3 IEEE 519: Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
  4 IEEE 587 / ANSI C62.41: Standards for Surge Withstand Ability
  5 IEEE 1184: Guide for Batteries for Uninterruptible Power Supply Systems
  6 IEEE 1187: Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications
  7 IEEE 1188: Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
D International Organization for Standardization (ISO):
  1 ISO 9001: Quality Management Systems – Requirements
  2 ISO 14001: Environmental Management Systems - Requirements With Guidance for Use
E National Fire Protection Association
  1 NFPA 70: National Electrical Code
  2 NFPA 75: Standard for the Protection of Information Technology Equipment
F Underwriters' Laboratories
  1 UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
  2 UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
  3 UL 1778: Standard for Uninterruptible Power Supply Equipment
  4 UL 2426: Spill Containment for Stationary Lead Acid Battery Systems
G International Electrotechnical Commission
  1 IEC 50091-2: Emissions Class A and Harmonics
  2 IEC 61000-4-2: Electromagnetic Compatibility - Testing and Measurement Techniques; Electrostatic Discharge Immunity Test
  3 IEC 61000-4-3: Electromagnetic Compatibility - Testing and Measurement Techniques; Radiated, Radio Frequency, Electromagnetic Field Immunity Test
  4 IEC 61000-4-4: Electromagnetic Compatibility - Testing and Measurement Techniques; Electrical Fast Transient/Burst Immunity Test

5 IEC 61000-4-5: Electromagnetic Compatibility - Testing and Measurement Techniques; Surge Immunity Test.
6 IEC 62040-2: Uninterruptible Power Systems - Electromagnetic Compatibility (EMC) Requirements
7 IEC 62040-3: Uninterruptible Power Systems - Method of Specifying the Performance and Test Requirements

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Supply equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state, and local codes.
D Items of a given type shall be the products of the same manufacturer.
E The manufacturer shall comply with ISO 9001.
F Factory Testing
1 Prior to shipment, the manufacturer shall completely test all functions of the UPS module and batteries (via a discharge test) in accordance with all applicable codes and standards.
2 The test procedure and results shall be documented and made available to the customer
G Inspect equipment for damage at the factory prior to shipping.
H Ship equipment in its original packages to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
I Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.
J Equipment containing batteries shall not be stored for a period exceeding three months without powering the equipment for a period to fully recharge the batteries.
K Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
L Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

1.5 SUBMITALS

A Submit under provisions of Section 013000 or 013300.
B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 Calibration procedures and intervals
7 A complete set of drawings for any special items
8 Wiring diagrams
C Shop Drawings: Submit complete fabrication details, elevations and sections of switchboard, dimensions, space available for conduits, rating, short circuit withstand ability of bus and lowest rated device, circuit schedule showing circuit number, device description, device frame ampere rating and trip, fuse clip ampere rating, termination lug size, feeder and circuit identification, conductor ratings and one-line and wiring diagrams. Include both elementary diagram and terminal to terminal wiring diagrams.
D Electronic submittals shall be searchable

E The submittal shall be substantially complete for all items and equipment furnished under this section.
F Individual drawings and data sheets submitted at random intervals will not be accepted for review.
G Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Manufacturer's data sheets – When data sheets include more than one model the model(s) used shall be noted
4 Manufacturer's programming, user, and maintenance manual(s), including trouble-shooting guidelines
5 Configuration settings
6 Wiring diagrams
7 Voltage ratings
8 Current ratings
9 Calibrated range
10 List of capabilities
11 Environmental ratings
12 NEMA enclosure type
13 Maintenance requirements
14 Installation instructions
15 Repair instructions
16 IEEE 1188: Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

1.7 WARRANTY

A UPS Module: The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of twelve (12) months from date of installation or acceptance by customer or eighteen (18) months from date of shipment from the manufacturer, whichever occurs first.
B Battery: The battery manufacturer's warranty shall be passed through to the final customer and shall have a minimum period of one year full replacement with a 4 year prorated warranty.

PART 2 – PRODUCTS

2.1 GENERAL

A UPS shall be a double conversion, on-line, reverse transfer system
B UPS shall be manufactured by Tripp-Lite.
C Uninterruptable power supplies supplying electronic loads shall be designed for such service.
D The UPS shall have a minimum efficiency of 89%.
E Capacity

1 The continuous output power rating of the UPS shall be shall be as shown on plans.
2 UPSs supplying lights shall be capable of supplying the full load for 90 minutes.
3 UPSs not supplying lights shall be capable of supplying the full load for 10 minutes.
4 UPSs used with back-up generator(s) shall be capable of supplying the full load for 30 seconds.

F The UPS shall be rated for the following conditions:
1 Temperature:
a UPS designed to operate without air conditioning
1 Operating: 4°F to 122°F
2 Non-Operating: -22°F to 140°F
b UPS designed to operate with air conditioning
1 Operating: 32°F to 78°F
2 Non-Operating: 32°F to 104°F
2 Relative humidity (operating and storage): 5 to 95% non-condensing
3 Barometric Pressure:
a Up to 3000 feet above sea level
b UPSs designed for harsh conditions may be operated up to 6500 feet with ambient temperature less than 84°F without air conditioning.
4 Verify model is suitable for the environment it will operate in.

G Audible noise shall be no more than 45 dBA at 3 feet.

H The rectifier, battery charger, and inverter shall be made by the same manufacturer and designed for use with all other components.

I Modules
1 The UPS components shall be a modular design allowing repair of the UPS by replacing modules.
2 All freestanding UPS modules and batteries shall be accessible from the front.

2.2 MODES OF OPERATION

A Normal: The rectifier/battery charger shall derive power from the AC source and supply DC power to the inverter and float charge the batteries. The inverter shall continuously supply power to the load.

B Emergency/Battery: Upon failure of the AC power source, power for the load shall be supplied from the batteries via the inverter without any switching.

C Recharge: Upon restoration of the AC power source the rectifier/battery charger shall power the inverter and simultaneously recharge the battery in accordance with UL 924 (no electronic loads) or UL 1778 (electronic loads) standards.

D Bypass: The static bypass transfer switch shall be used to transfer the load from the inverter to the bypass and from the bypass to the inverter without interruption to the load.

E Manual Bypass: A make before break, manual bypass switch shall be provided to electrically isolate the UPS providing continuous power to the load.

F UPS housing (small, rack or wall mounted) / enclosure (large, freestanding)

2.3 INPUT

A Input to UPS
1 Voltage shall be as shown on the plans
2 Input current shall go from 0% to 100% over a 10-second period with inrush not to exceed nominal input current for less than one cycle
3 Provide surge protection shall meet the requirements of one of the options below and Section 264300.
a Surge protection shall be external to UPS meeting IEEE 587
b Surge protection that is internal to the UPS shall meet IEEE 587 and be replaceable.

B Rectifier

1 The rectifier shall provide high quality DC power to charge the batteries and power the inverter.

2 It shall have the following characteristics:

a Input Current Limiting: The UPS shall be equipped with a system designed to limit the battery charging current to conform to UL 924 or UL 1778 (electronic loads) standards.

b Capacity: The rectifier shall have sufficient capacity to support a fully loaded inverter and fully recharge the battery in accordance with UL 924 (no electronic loads) or UL 1778 (electronic loads).

2.4 DC COMPONENTS

A Direct Current Bus

1 The battery charger shall compensate for temperature changes in accordance with the battery manufacturer's requirements.

2 UPS shall utilize software to control DC voltage to extend life of batteries.

B Battery Charger

1 Charging Levels: The battery charging circuitry shall be capable of being set for automatic battery recharge operation, float service, and equalizing operation.

2 Temperature Compensated Charging: UPSs not in an air conditioned space or enclosure shall have a battery charger equipped with a temperature probe to enable temperature compensated charging and adjust the battery float voltage to compensate for the ambient temperature using a negative temperature coefficient of 5.4 mV per cell per degree Fahrenheit at a nominal temperature of 77°F.

2.5 OUTPUT

A Inverter

1 The UPS output shall be derived from a Pulse Width Modulated (PWM) IGBT inverter design.

2 The inverter shall be capable of providing precise output power while operating over the battery voltage range.

B Output from UPS

1 Voltage shall be as shown on the plans

2 Voltage Regulation: $\pm$ 3% no load to full balanced load and full battery run mode

3 Frequency: 60 Hz ($\pm$ 0.1 Hz when free running).

4 Voltage Distortion:

a Maximum 5% total (THD) with 100% linear loads

b Maximum 6.5% total (THD) with non-linear loads

5 Voltage Transient (Step Load) Response:

a + 5% for 50% step load change

b $\pm$ 8% for 100% step load change

c $\pm$ 3% for loss or return of AC input power or manual transfer at full load.

6 Voltage Recovery Time: Return to within 3% of nominal value within 50 milliseconds.

7 Phase Angle Displacement

a 120° $\pm$ 1° degrees for balanced load

b 120° $\pm$ 3° degrees for 100% unbalanced load

8 Non-Linear Load Capability: Output voltage total harmonic distortion shall be less than 8% when connected to a 100% non-linear load with a crest factor not to exceed 2.5%.

9 Inverter Overload Capability:

a 125% of rated load for 1 minute

b 145% of rated load for 10 seconds

10 Bypass Overload Capability: > 200% for one cycle; > 150% for 30 seconds
11 All 3-phase UPSs shall be capable of supplying 1-phase and 3-phase loads.

2.6 BYPASSES

A Static Bypass: The static bypass switch shall be solid-state, rated for continuous duty and shall operate under the following conditions:
1 The static bypass transfer switch shall automatically bypass the rectifier and inverter and switch the load to utility power without interruption when the logic senses one of the following conditions:
a Inverter overload exceeds unit's rating
b Battery protection period expired and bypass current is available
c Inverter failure
2 The static bypass switch shall automatically transfer the load back to the rectifier and inverter without interruption once the condition that caused the transfer has been fixed.
B Manual bypass switch
1 Provide a bypass switch for UPS isolation.
2 The switch shall transfer the load without interruption
3 The switch shall have mechanical keyed interlocks to protect the UPS from damage in the event of out of sequence transfers

2.8 CONTROLLER

A Control
1 The UPS shall be controlled by a microprocessor.
2 UPS shall be equipped with a self-test function to verify correct system operation.
3 All operations and parameters shall be firmware controlled.
4 The logic shall include a self-test and diagnostic circuitry such that a fault can be isolated down to the printed circuit assembly or plug-in power assembly level.
5 Time-stamped historical events: This function shall time-stamp and store all important status changes, anomalies and faults and make this information available for automatic or user-requested consultation; it shall interpret the events and indicate remedial measures if applicable.
6 Remote Off switch: The UPS shall have the capability for remote activation of the off function via an isolated dry contact to create an emergency power off function, resulting in:
a Inverter shutdown
b Inhibiting of the automatic bypass
7 The electronic UPS control and monitoring assembly shall be fully microprocessor based.
a Auto-compensation of component drift
b Self-adjustment of replaced subassemblies
c Extensive acquisition of information vital for computer-aided diagnostics
B The UPS shall include an operator interface
1 LCD or LED display
a Password protection
b UPS status/mode
c Input voltage on all phases
d Input amps on all phases
e DC voltage
f Battery status
g Battery temperature
h Low-battery warning
i Output voltage on all phases
j Output amps on all phases

k Event log with time stamp
l Alarm event log
m Load on battery
n Load on UPS
o Load on automatic bypass
p General alarm
q Additional indications shall provide maintenance assistance
r Faults
1 Ground current
2 DC overvoltage
3 IGBT over current
4 IGBT over temperature
5 Control system faults
6 Communications faults

2 Pushbuttons for operating the UPS

C Communications

1 The UPS shall have a RJ-45 Ethernet port for remote monitoring and remote alarm indications via e-mail or text message.

2 The UPS shall have one of the following connections for field diagnostics.
a RS-232
b RS-485
c RJ-45 Ethernet (in addition to RJ-45 port above)

3 The UPS shall have capabilities for one of the following protocols
a SNMP
b Modbus

4 Electronic access to UPS shall be password protected.

5 The UPS shall have provisions for contacts. The contacts will be normally open and will change state to indicate the operating status. The contacts will be rated at 2.0 A ($125V_{AC}$ / $30V_{DC}$). Contacts shall be programmed as:
a Power On
b Load on Utility
c On Battery
d Inverter On
e Summary Alarm

D UPS shall be equipped with a self-test function to verify correct system operation.

2.9 BATTERIES

A The batteries shall be valve regulated, sealed, lead calcium, heavy-duty industrial (VRLA) batteries, designed for auxiliary power service in a UPS application.

B The battery cases shall be impact resistant plastic and be housed within the UPS.

C If the UPS requires separate battery enclosure(s), it (they) shall match the UPS enclosure.

D Protection against deep discharge and self-discharge

1 The UPS shall be equipped with a device designed to protect the battery against deep discharge depending on discharge conditions, with isolation of the battery by a circuit breaker.

2 The UPS shall have a monitoring device shall adjust the battery shutdown voltage as a function of a discharge coefficient to avoid excessive discharge at less than the rated output.

E Battery Self-Tests: The battery monitoring system shall perform the following automatic functions:

1 Battery circuit check

2 Partial discharge test (customer selectable)

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install all equipment per manufacturers' instructions.
B. Freestanding UPS
   a. Mount 6" high concrete pad provided under this Division.
   b. Properly align and level UPS with adjacent equipment.
   c. Anchor to floor with 1/2" diameter minimum anchor bolts. Bolts and washers shall be galvanized. Strength of materials used to secure the switchboard shall be sufficient to resist shear and uplift produced by force equal to one half of the equipment mass applied horizontally at center of gravity.
C. Wall mounted UPS: Provide all necessary blocking, channels and other hardware for securing UPS to wall, column or other parts of building structure.
D. Rack mounted UPS: Secure UPS to rack at both front channels and both back channels of rack.
E. Provide and install Cat-6a connection from UPS data port to LAN.
F. Program UPS to allow monitoring and to send messages (e-mail, text, etc.) for alarm conditions.

3.2 GROUNDING

A. Ground equipment per manufacturer's instructions, Section 260500, and applicable codes.
B. Minimize resistance from device to ground.
C. Resistance from device to ground shall not exceed 25 ohms.

3.3 SITE TESTING AND START-UP

The UPS system will be checked, started-up and tested on-site by a manufacturer's qualified field service engineer.

3.4 TRAINING

The manufacturer shall provide UPS maintenance and operation training to the customer.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

Owner: _____ Equipment Serial #: _____
Equipment ID #:_____ Equipment/System: _____
Project #: _____ Specification Section: 263410

I hereby certify that the above-referenced equipment/system has been:
(Check Applicable)

_____ Installed in accordance with Manufacturer's recommendations.
_____ Inspected, checked, and adjusted.
_____ Serviced with proper initial lubricants.
_____ Electrical and mechanical connections meet quality and safety standards.
_____ All applicable safety equipment has been properly installed.
_____ System has been performance tested and meets or exceeds specified requirements.
(When complete system of one manufacturer)

Comments:_____
_____
_____
_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Print Name)

_____
(Authorized Signature)

SECTION 271100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section includes material and workmanship requirements for intermediate data frames (IDFs), main data frames (MDFs), and signal and communications terminal backboards (SCTBs) including, but not limited to, cabinets, racks, patch panels, cable terminations, patch cables, and power distribution.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. All included sections under Division 1
B. All included sections under Division 26
C. All included sections under Division 27
D. Plans
E. Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A. Governing Codes and Conflicts: If the requirements of the Construction Documents exceed those of the governing codes and regulations, then the requirements of the Construction Documents shall prevail. Where a conflict exists, the governing codes and ordinances shall supersede all other requirements.
B. ANSI: American National Standards Institute (ANSI)
C. CEC: California Electrical Code
D. Electronic Components Association (ECA)
    1. ECA-310-E: Cabinets, Racks, Panels, and Associated Equipment
E. Institute of Electrical and Electronic Engineers (IEEE)
    1. IEEE 802.3: IEEE Standard for Ethernet
    2. IEEE 802.3ad: Link Aggregation
    3. IEEE 802.3ae: 10 Gigabit Ethernet
    4. IEEE 802.3af: Power over Ethernet
    5. IEEE 802.3an: 10 Gigabit Ethernet on Twisted Pair Copper Cable (10G Base T)
    6. IEEE 802.3aq: 10 Gigabit Ethernet on FDDI-Grade Multimode Fiber (10G Base LRM)
    7. IEEE 802.3at: Enhanced Power over Ethernet
F. Telecommunications Industries Association (TIA)
    1. TIA-526: Standard Test Procedures for Fiber Optic Systems
    2. TIA-526-2-A: Effective Transmitter Output Power Coupled into Single-Mode Fiber Optic Cable
    3. TIA-526-7-A: Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant: Fiber-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement
    4. TIA-526-14-C: Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant: Installed Cable Plant-Multimode Attenuation Measurement
    5. TIA-526-19: Optical Signal-to-Noise Ratio Measurement Procedures for Dense Wavelength – Division Multiplexed Systems
    6. TIA-526-28-2021: Fiber-Optic Communication Subsystem Test Procedures- Part 4-5: Installed Cabling Plant- Attenuation Measurement of MPO Terminated Fiber-Optic Cabling Plant Using Test Equipment with MPO Interfaces
    7. TIA-568-D: Commercial Building Telecommunications Standard
    8. TIA-568.0-D: Generic Telecommunications Cabling for Customer Premises
    9. TIA-568.1-E: Commercial Building Telecommunications Cabling Standard

10. TIA-568.2-D: Balanced Twisted-Pair Telecommunications Cabling and Components Standards
11. TIA-568.3-E: Optical Fiber Cabling Components Standard
12. TIA-568.4-E: Broadband Coaxial Cabling and Components Standard
13. TIA-568.5-2022: Balanced Single Twisted-pair Telecommunications Cabling and Components Standard
14. TIA-569-E: Commercial Building Standard for Telecommunications Pathways and Spaces
15. TIA-604-1-1996: Fiber Optic Connector Intermateability Standard
16. TIA-604-10-C: Fiber Optic Connector Intermateability Standard – Type LC
17. TIA-606-D: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
18. TIA-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
19. TIA-758-B: Customer Owned Outside Plant Telecommunications Infrastructure Standard
20. TIA-1005-A: Telecommunications Infrastructure Standard for Industrial Premises
21. TIA-1152-A: Requirements for Field Test Instruments and Measurements for Balanced Twisted – Pair Cabling
22. TIA-1183-A: Measurement Methods and Test Fixtures for Balun-less Measurements of Balanced Components and Systems
23. TIA-4071-2022: Requirements for Field Test Instruments and Measurements for Balanced Single Twisted-Pair Cabling
24. TIA-5017-2016: Telecommunications Physical Network Security Standard
25. TIA-TSB-36: Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted-Pair Cables
26. TIA-TSB-62: Informative Test methods for Fiber-Optic Fibers, Cables, Opto-Electronic Sources and Detectors, Sensors, Connecting and Terminating Devices, and Other Fiber-Optic Components
27. TIA-TSB-63: Reference Guide for Fiber Optic Test Procedures
28. TIA-TSB-149: Generic Workmanship Guidelines for Fiber Optic Connector Interoperability
29. TIA-TSB-143: Fiber Optic Power Meters: Measurement and Application Issues
30. TIA-TSB-1197: Mode Conversion Parameters for Balanced Twisted Pair Cabling
31. TIA-TSB-4947: Guidance for Adhesive Usage in Fiber Optic Components
32. TIA-TSB-4979: Practical Considerations for Implementation of Encircled Flux Launch Conditions in the Field
33. TIA-TSB-5008: Mechanically-Generated Balanced Twisted-Pair Cable Impulse Noise Detection and Characterization
34. TIA-TSB-5019: High Performance Structured Cabling Use Cases for Data Centers and Other Premises

G. Underwriters Laboratories, Inc.
1. UL 489A: Circuit Breakers for Use in Communications Equipment
2. UL 497: Protectors for Paired-conductor Communications Circuits
3. UL 497A: Secondary Protectors for Communications Circuits
4. UL 497D: Component Secondary Protectors for Communications Circuits Used With Specified Voltage Suppression
5. UL 1449: Surge Protective Devices
6. UL 1690: Standard for Data-Processing Cable
7. UL 1778: Uninterruptible Power Systems
8. UL 1801: Power Distribution Centers for Communications Equipment
9. UL 1863: Communications Circuit Accessories
10. UL 1977: Component Connectors for Use in Data, Signal, Control, and Power Applications
11. UL 2024: Standard for Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies

12. UL 2269: Optical Fiber/Communications/Signaling/Coaxial Cable Outlet Boxes
13. UL 2416: Audio/Video, Information, and Communication Technology Equipment Cabinet, Enclosure, and Rack Systems
14. UL 60950-1: Information Technology Equipment Safety – Part 1: General Requirements
15. UL 60950-22: Information Technology Equipment - Safety - Part 22: Equipment to be Installed Outdoors
16. UL 62368-1: Audio/video, information and communication technology equipment - Part 1: Safety requirements

1.4 QUALITY ASSURANCE

A. Contractor requirements:
   1. The Contractor shall have successfully completed a minimum of 5 telecommunications projects of the same size and scope.
   2. Project Manager
      a. The Project Manager shall have successfully completed a minimum of 5 telecommunications projects of the same size and scope.
      b. The contractor shall make the project manager available to the Owner/Owner's Representative before the start of this project for an interview. This person must be deemed acceptable by the Owner and/or their Representative before work can begin.
      c. Project Manager will be required to be available for scheduled on site project meetings at no additional cost to the Owner.
      d. Project Manager will be required to be available to meet on site with the Owner/Owner's representative with a minimum of 24 hours notice for non-emergency issues, and a minimum of 4 hours for emergency issues at no additional cost to the Owner.
   3. The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context 'good quality' means the work shall meet industry technical standards and quality of appearance. The Owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.
   4. The Contractor shall provide all necessary materials and labor for a complete, functional Telecommunications cabling infrastructure in accordance with all applicable standards and the Construction Documents.

B. Material requirements
   1. All material and equipment to be installed on this project will be new and free from defects.
   2. Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
   3. New material shall meet the following requirements.
      a. Manufactured within one year of the installation date.
      b. Undamaged
      c. Not previously installed
      d. Delivered to jobsite in original packaging
      e. No corrosion or other degradation of material
      f. In factory condition
      g. Unmodified
   4. If used material or equipment has been installed on this project the Contractor shall replace said materials and/or equipment with new products at no additional cost to the Owner.
   5. Equipment and accessories shall comply with the applicable standards listed in Article 1.3 of this section and with applicable national, state, and local codes.
   6. Items of a given type shall be the products of the same manufacturer.
   7. Deliver, store, and protect products under provisions of Section 016200.

8. Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
9. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
10. Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

C. Contractor shall warranty all materials, equipment, and workmanship for a minimum of one (1) year.
1. Warranty shall provide repair/replacement of all defective or improperly installed materials at no additional cost to the Owner (including all costs to repair or replace the item(s)).
2. Contractor shall provide a competent service technician and new materials to repair/replace defective items no later than 24 hours after notification.

D. The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context 'good quality' means the work shall meet industry technical standards and quality of appearance. The Owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

E. The Contractor shall provide all necessary materials and labor for a complete, functional Telecommunications cabling infrastructure in accordance with all applicable standards and the Construction Documents.

1.5 SUBMITTALS

A. Submit under provisions of Section 013000 or 013300.

B. Submittals shall include the following:
1. Table of contents
2. A complete set of detailed manufacturers' specifications describing and illustrating all standard and special components and materials
3. Part numbers
4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5. Maintenance instructions and intervals
6. A complete set of drawings for any special items
7. A single line block diagram showing exactly the manner in which the contractor proposes to layout the system.
8. Wiring diagrams
9. Illustrations and scale drawing of the racks, equipment layouts etc.
10. Drawings shall include designations, dimensions, operating controls, instruments, riser diagrams, routing diagrams etc.

C. Electronic submittals shall be searchable.

D. The submittal shall be substantially complete for all items and equipment furnished under this section.

E. Individual drawings and data sheets submitted at random intervals will not be accepted for review.

F. Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A. Submit operation and maintenance manuals in accordance with Section 260000.

B. The manuals shall, at minimum, include the following:
1. Table of contents
2. Manufacturer (including contact information)
3. Model number
4. Wiring diagrams

5. Voltage ratings
6. Current ratings
7. List of capabilities
8. Environmental ratings
9. NEMA enclosure type
10. Maintenance instructions and intervals
11. Calibration procedures and intervals
12. Installation instructions
13. As-built drawings

C. Provide manuals in one of the following formats
1. Three hardcopies
2. PDF

PART 2 – PRODUCTS

2.1 GENERAL

A. Provide all necessary mounting hardware.
B. All materials shall be UL listed for its application.
C. All materials shall have been tested and certified by a Nationally Recognized Testing Laboratory as meeting the requirements of all applicable, listed standards.

2.2 COPPER PATCH PANELS

A. Patch panels
1. 24 Ports: Ortronics #SPKSU24
2. 48 Ports: Ortronics #SPKSU48

B. Data ports
1. RJ-45 design
2. Terminate 26AWG to 22 AWG, stranded or solid, Cat-6A cables without punch-down tool
3. Suppress alien cross-talk
4. Maintain 10GB/S performance in 48 port, 1RU patch panels
5. T568B wiring scheme
6. Meet or exceed Cat-6A requirements of TIA-568.2-D and IEEE 802.3an.
7. Compatible with IEEE 802.3at POE+
8. Snap in, snap out modular design
9. Conductor retention and strain relief
10. Gold plated contacts
11. Data ports shall be Ortonics #KT2J6A-xx. Replace xx with number for appropriate color.
12. Ports in patch panels shall be grouped by use (data, VOIP, clock/public address, etc.)
13. Colors for RJ-45 ports shall be:
    a. Access control: Black
    b. Clocks: Yellow
    c. Data: White
    d. Speakers: Yellow
    e. Surveillance: Blue
    f. Wireless access points: Green

C. Patch cords
1. RJ-45 design
2. Four twisted, unshielded, 24 AWG, solid pairs (24 AWG UTP)
3. Suppress alien cross-talk
4. Maintain 10GB/S performance

5. T568B wiring scheme
6. Meet or exceed Cat-6A requirements of TIA-568.2-D and IEEE 802.3an.
7. SRL, Attenuation, & NEXT results shall use Sweep Frequency test per TIA-568-D.
8. Compatible with IEEE 802.3at POE+
9. Snagless latch on plugs
10. Length shall be 12 inches for patch cords between patch panel and switch mounted directly above or below the patch panel.
11. Patch cords shall be Quiktron #576-Axx-yyy. Replace xx with appropriate number for the required color and yyy with length in feet.
12. Colors for RJ-45 patch cables shall be:
    a. Access control: Black
    b. Clocks: Yellow
    c. Data: Blue
    d. Speakers: Yellow
    e. Surveillance: Blue
    f. Wireless access points: Green

D. Ortronics color codes:
1. 00 = Gray
2. 10 = Blue
3. 15 = Yellow
4. 20 = Green
5. 25 = White
6. 30 = Red
7. 35 = Black
8. 40 = Orange
9. 45 = Purple

2.3 FIBER OPTIC PATCH PANELS

A. Fiber enclosure: Ortronics #INFC01U-M4-E
B. Fiber adapter panels (FAP)
1. OS2
2. 6 Duplex LC adapters per FAP
3. Zirconia ceramic, split sleeve ferrules
4. Color: Blue
5. Ortronics #HDFP-LCD12AC

C. Optical fiber termination kit: Ortronics #205KAN9GA-SM
D. Fiber optic cable fanout kit: Ortronics #61500858
E. Fiber optic patch cords
1. Coordinate connectors with switch ports and patch panels.
2. Length shall be 8 inches for patch panel adjacent to switch. Add 1.75 inches to length for each rack unit separating patch panel from switch.
3. Multi-mode patch cords shall be OM4. Single-mode patch cords shall be OS2.
4. Cord and connector colors shall match adapter colors.

PART 3 – EXECUTION

A. Rack mounted equipment
1. Securely fasten all rack mounted equipment to each rack rail with a minimum of two screws per rail and according to manufacturers' recommendations.
2. Patch panels shall be mounted to front pair of rack rails.
3. PDUs shall be mounted to rear pair of rack rails.
4. All other equipment shall be mounted to both pairs of rack rails.
5. Alternate patch panels and switches so that each port in the patch panel is adjacent to the corresponding port in the switch.

B. Cable management
   1. Install vertical cable management raceways on each post of freestanding racks.
   2. Install fiber optic storage ring on backboard behind each IDF/MDF or in rear of IDF cabinet. Loop each fiber optic cable round ring 3 times. Install ID tag on loop of each cable.

C. Grounding and Bonding
   1. Each MDF and IDF shall be equipped with a grounding busbar.
   2. Each grounding busbar shall be connected to the building electrical grounding facility per plans.
   3. All metallic equipment, including but not limited to, each rack, metallic backboard, cable sheath, metallic strength member, splice case, cable tray shall be grounded to its respective grounding busbar using a minimum #6 AWG stranded copper bonding conductor with a green insulation and compression connectors.
   4. Wall mounted grounding busbars
      a. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions and Typical Electrical Details.
      b. Conductor connections to the grounding busbar shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
      c. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
      d. The wall-mounted busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
   5. Rack-Mount Busbars and Ground Bars
      a. Each rack and cabinet shall be equipped with a vertical grounding busbar.
      b. Attach rack-mount busbars and ground bars to racks according to the manufacturer's installation instructions.
      c. Bond the rack-mount grounding busbar to the rack, cabinet, and room's grounding busbar with appropriately sized hardware and conductor.
   6. Equipment Ground Jumper Kit
      a. Bond equipment to a vertical rack-mount grounding busbar using ground jumper according to the manufacturer's recommendations.
      b. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount grounding busbar to help prevent corrosion at the bond.

D. Program UPSs, PDUs, and software to set alarms for current overload, temperature out of limits, and humidity out of limits and send email notification of alarm conditions.

3.2 LABELING

A. The contractor shall follow the Owner's labeling scheme.
B. Each IDF and MDF shall be labeled.
C. Each IDF, MDF, patch panel, port, switch, and cable shall have a unique identification.
D. Label each port on the patch panel and faceplate with its identification.
E. Label each cable at its beginning and end points no further than 6" behind termination on a section of cable that is easily accessible. Cable labels shall include the ids of both terminations and cable id.
F. Label the plug end of each power cord with id of equipment it feeds.
G. Each faceplate shall be machine labeled. The labeling shall be placed on the faceplate so that the individual jack can be clearly identified by its associated label.
H. All labels shall be machine printed. Handwritten labels are not acceptable.
I. All labeling information shall be recorded on the as-built drawings and all test documents.

3.3 SYSTEM CLOSEOUT AND AS-BUILT DOCUMENTATION

A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Owner's Representative/Engineer for approval. One (1) to be a hardcopy and two (2) to be electronic copies. Documentation shall include the items detailed in the sub-sections below.

B. Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 calendar days of the completion of each testing phase. At the request of the Owner's Representative/Engineer, the telecommunications contractor shall provide copies of the original test results.

C. The Owner's Representative/Engineer will request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

D. Test Results documentation shall be provided in two media, as listed above, one (1) hardcopy and one (1) on disk within three weeks after the completion of the project. The documentation shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an bi-annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

E. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package.

F. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

G. The As-Built drawings are to include cable routes, outlet locations and the approved labeling identifiers. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD 2008) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

H. Contractor will provide one laminated 11"x17" drawing at each IDF and MDF that includes the building layout for that IDF or MDF, along with the outlet locations and all of the approved labeling.

END OF SECTION

SECTION 271500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section includes material and workmanship requirements for data, IP clocks, and IP speakers horizontal cabling.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A All other included sections under Division 1
B All included sections under Division 26
C All included sections under Division 27
D Plans
E Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A. Governing Codes and Conflicts: If the requirements of the Construction Documents exceed those of the governing codes and regulations, then the requirements of the Construction Documents shall prevail. Where a conflict exists, the governing codes and ordinances shall supersede all other requirements.
B. ANSI: American National Standards Institute (ANSI)
C. CEC: California Electrical Code
D. Institute of Electrical and Electronic Engineers (IEEE)
   1. IEEE 802.3: IEEE Standard for Ethernet
   2. IEEE 802.3ad: Link Aggregation
   3. IEEE 802.3ae: 10 Gigabit Ethernet
   4. IEEE 802.3af: Power over Ethernet
   5. IEEE 802.3an: 10 Gigabit Ethernet on Twisted Pair Copper Cable (10G Base T)
   6. IEEE 802.3aq: 10 Gigabit Ethernet on FDDI-Grade Multimode Fiber (10G Base LRM)
   7. IEEE 802.3at: Enhanced Power over Ethernet
E. Insulated Cable Engineers Association (ICEA)
   1. ICEA S-84-608: Telecommunications Cables, Filled Polyolefin Insulated, Copper Conductor
   2. ICEA S-86-634: Buried Distribution and Service Wire, Filled Polyolefin Insulated, Copper Conductor
   3. ICEA S-102-700: ICEA Standard for Category 6 Individually Unshielded, Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in Communications Wiring Systems Technical Requirements
   4. ICEA S-103-701: Riser Cables Technical Requirements
F. Telecommunications Industries Association (TIA)
   1. TIA-568-D: Commercial Building Telecommunications Standard
   2. TIA-568-D.0: Generic Telecommunications Cabling for Customer Premises
   3. TIA-568-D.1: Commercial Building Telecommunications Cabling Standard
   4. TIA-568-D.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standards
   5. TIA-569-E: Commercial Building Standard for Telecommunications Pathways and Spaces
   6. TIA-606-C: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
   7. TIA-607-D: Commercial Building Grounding and Bonding Requirements for Telecommunications
   8. TIA-758-B: Customer Owned Outside Plant Telecommunications Infrastructure Standard

9. TIA-1152: Requirements for Field Test Instruments and Measurements for Balanced Twisted Pair Cabling
10. TIA-1183: Measurement Methods and Test Fixtures for Balun-less Measurement of Balanced Components and Systems
11. TIA-TSB-36: Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted-Pair Cables
12. TIA-TSB-62: Informative Test methods for Fiber-Optic Fibers, Cables, Opto-Electronic Sources and Detectors, Sensors, Connecting and Terminating Devices, and Other Fiber-Optic Components
13. TIA-TSB-63: Reference Guide for Fiber Optic Test Procedures
14. TIA-TSB-67: TIA Telecommunications Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted-Pair Connecting Hardware
15. TIA-TSB-149: Generic Workmanship Guidelines for Fiber Optic Connector Interoperability
16. TIA-TSB-155: Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBase-T
17. TIA-TSB-184: Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
18. TIA-TSB-1197: Mode Conversion Parameters for Balanced Twisted Pair Cabling

G. Underwriters Laboratories, Inc.
1. UL 444: Communications Cables
2. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
3. UL 1690: Standard for Data-Processing Cable
4. UL 1863: Communications Circuit Accessories
5. UL 1977: Component Connectors for Use in Data, Signal, Control, and Power Applications
6. UL 2024: Standard for Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies
7. UL 2269: Optical Fiber/Communications/Signaling/Coaxial Cable Outlet Boxes
8. UL 62368-1: Audio/video, information and communication technology equipment - Part 1: Safety requirements

1.4 QUALITY ASSURANCE

A Contractor requirements:
1 The Contractor shall have successfully completed a minimum of 5 telecommunications projects of the same size and scope.
2 Project Manager
a The Project Manager shall have successfully completed a minimum of 5 telecommunications projects of the same size and scope.
b The contractor shall make the project manager available to the Owner/Owner's Representative before the start of this project for an interview. This person must be deemed acceptable by the Owner and/or their Representative before work can begin.
c Project Manager will be required to be available for scheduled on site project meetings at no additional cost to the Owner.
d Project Manager will be required to be available to meet on site with the Owner/Owner's representative with a minimum of 24 hours notice for non- emergency issues, and a minimum of 4 hours for emergency issues at no additional cost to the Owner.
3 The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context 'good quality' means the work shall meet industry technical standards and quality of appearance. The Owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

4 The Contractor shall provide all necessary materials and labor for a complete, functional Telecommunications cabling infrastructure in accordance with all applicable standards and the Construction Documents.

B Material requirements
1 All material and equipment to be installed on this project will be new and free from defects.
2 Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
3 New material shall meet the following requirements.
a Manufactured within one year of the installation date.
b Undamaged
c Not previously installed
d Delivered to jobsite in original packaging
e No corrosion or other degradation of material
f In factory condition
g Unmodified
4 If used material or equipment has been installed on this project the Contractor shall replace said materials and/or equipment with new products at no additional cost to the Owner.
5 Equipment and accessories shall be in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state and local codes.
6 Items of a given type shall be the products of the same manufacturer.
7 Deliver, store and protect products under provisions of Section 016200.
8 Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.
9 Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.
10 Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

C Contractor shall warranty all materials, equipment, and workmanship for a minimum of one (1) year.
1 Warranty shall provide repair/replacement of all defective or improperly installed materials at no additional cost to the Owner (including all costs to repair or replace the item(s)).
2 Contractor shall provide a competent service technician and new materials to repair/replace defective items no later than 24 hours after notification.

D The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context ‘good quality’ means the work shall meet industry technical standards and quality of appearance. The Owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

E The Contractor shall provide all necessary materials and labor for a complete, functional Telecommunications cabling infrastructure in accordance with all applicable standards and the Construction Documents.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.

B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section

5 A riser diagram showing exactly the manner in which the contractor proposes to layout the system.
6 Wiring diagrams

C Electronic submittals shall be searchable

D The submittal shall be substantially complete for all items and equipment furnished under this section.

E Individual drawings and data sheets submitted at random intervals will not be accepted for review.

F Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.

B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Voltage ratings
4 List of capabilities
5 Environmental ratings
6 Maintenance requirements
7 Installation instructions
8 Repair instructions

C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 GENERAL

A. All materials shall be UL listed for its application.

B. All materials shall have been tested and certified by a Nationally Recognized Testing Laboratory as meeting the requirements of all applicable, listed standards.

C. Cables shall be rated for its intended use, i.e. plenum, riser, wet location, etc.

D. Cables, conductors, and all other components shall meet the requirements of standards listed in Section 1.3.

2.2 DATA AND VOIP HORIZONTAL CABLING

A. Contractor shall provide, install, and test a Cat-6A cable link from each Data/VOIP Outlet directly to the IDF utilizing the hardware listed below (or approved equivalent) in full compliance with all applicable standards, local and national codes, manufacturers' recommendations, and otherwise noted within these specifications.

B. Specifications:
1. Four twisted, unshielded, 23 AWG, solid copper pairs (23 AWG UTP)
2. Suppress cross-talk
3. Maintain 10GB/S performance
4. Meet or exceed Cat-6A requirements of TIA-568-C.2 and IEEE 802.3an.
5. SRL, Attenuation and NEXT results shall use Sweep Frequency test per TIA-568-C.
6. Have UL verification to Cat-6A specifications.
7. Compatible with IEEE 802.3at POE+
8. Cables shall be white. Indoor/outdoor cables shall black.
9. Berk-Tek #11143100 (riser), 11141651 (plenum), or 11142753 (indoor/outdoor).

C. Cables shall be rated for their intended use, i.e. plenum, riser, wet location, etc.
D. Cables, conductors, and all other components shall meet the requirements of the standards listed in Section 1.3.
E. Provide all termination accessories, dressing accessories, enclosures, and testing for a complete fiber optic distribution system. Refer to Specification Section 271100.
F. Contractor shall determine cable "link" quantities as shown on the Construction Documents.

2.3 OUTLET HARDWARE

A Data and VOIP Ports:
1 RJ-45 design
2 Terminate 26AWG to 22 AWG, stranded or solid, Cat-6A cables without punch-down tool
3 Suppress alien cross-talk
4 Maintain 10GB/S performance in 48 port, 1RU patch panels
5 T568B wiring scheme
6 Meet or exceed Cat-6A requirements of TIA-568.2-D and IEEE 802.3an.
7 Compatible with IEEE 802.3at POE+
8 Snap in, snap out modular design
9 Conductor retention and strain relief
10 Gold plated contacts
11 Data ports shall be Ortonics #KT2J6A-xx. Replace xx with number for appropriate color.
12 Ports in patch panels shall be grouped by use (data, VOIP, clock/public address, etc.)
13 Colors for ports shall be:
a Access control: Black
b Clocks: Yellow
c Data: White
d Speakers: Yellow
e Surveillance: Blue
f Wireless access points: Green

B Wallplates:
1 Ortronics #KSFP2-99
2 Provide an install a blank module for each unused opening in the wallplate.

C Back box: 4 inch square box with one gang plaster

2.4 MISCELLANEOUS MATERIALS

A Conduits: Refer to Section 260500.
B Supports: Refer to Section 260529.
C J-Hooks shall be steel with closure and two bolt holes. Finished part shall be hot dipped galvanized.

PART 3 – EXECUTION

3.1 INSTALLATION

A Cables
1 Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.
2 Contractor shall use Velcro strip to bundle cables together. Tie Wraps will not be allowed for supporting, bundling, and/or dressing of any cables.

3 Contractor shall provide a three foot service loop for all cables. The service loop will be coiled and secured using Velcro in the accessible ceiling at the conduit stub to the work area outlet box.

4 A 1/8" diameter, nylon pull cord shall be co-installed with all cable installed in any conduit.

5 Cable raceways shall not be filled greater than the TIA-569-C maximum fill for the particular raceway type or 40%.

6 Cables shall be installed in continuous lengths from origin to destination. Splices are not permitted.

7 Do not exceed the manufacturer's minimum bend radius and maximum pulling tension for cables.

8 Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

9 Cables shall be dressed and terminated in accordance with the recommendations made in the TIA-568-C standards, manufacturer's recommendations, and best industry practices.

10 The cable jacket shall be maintained to within 1/2 inch of the termination point.

11 Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable every 3 feet.

12 Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

13 All cables shall be neatly bundled and dressed continuously from the entrance point of the data room or cabinet to their respective panels. Each panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame. Cables in all other rooms shall be concealed.

14 Inside Buildings: Cable and conductors shall be routed in conduit, or surface mounted raceway, run overhead and parallel to the structure.

- a Conduit shall be rigid steel, IMC, or EMT as described elsewhere in these specifications.
- b Plastic conduit shall not be used above grade.
- c Cable may be used behind accessible T-bar ceilings without conduit. Mount cable at the roof joist (or bottom of floor above) on 1" wide 'J-hooks' or 'bridle-rings' at every 5'-0" or less. Support each cable within 1'-0" of its termination point. Run cable parallel and perpendicular to the building structure and provide mechanical support for vertical runs by using Unistrut channel securely fastened in place.
- d Cable and conductors shall not be attached to the support wire of the T-bar ceiling or laid across the ceiling boards.

15 Between buildings: Cable and conductors shall be routed in conduit run underground.

- a Conduit shall be rigid steel, IMC, or plastic as described elsewhere in these specifications.
- b The use of EMT is not acceptable.

16 On the roof: Conduit shown on the drawings as being on the roof of the building or covered walkway shall be installed on 4" by 4" pressure treated wood blocking (sleepers) attached to the structure every 8'-0" or less.

- a Conduit shall be rigid steel or IMC as described elsewhere in these specifications.
- b The use of EMT or plastic conduit is not acceptable.

17 Make all underground runs continuous without splices or taps. Use underground boxes for *pulling purposes only*.

18 Only use pulling grip approved by the cable manufacturer.

19 Clean conduit with mandrel prior to pulling.

20 Make all connections and splices in a clean environment.

21 Follow cable manufacturer's and device manufacturer's instructions for connections to devices.
22 Maximum combined cable length (patch cords and installed cable) from switch to end user equipment shall be 328 feet.
23 Stranded conductors shall be "tinned" with solder before terminations are made.
24 Make all terminations in cabinets and at terminal backboards on terminal blocks and/or Patch Panels as specified above.

B Outlets Installation
1 No more than 12" of cable shall be stored in an outlet box, modular furniture raceway, or insulated walls.
2 Data jacks, unless otherwise noted in drawings, shall be located in the top position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the left-most position(s).
3 Voice jacks, unless otherwise noted in drawings, shall occupy the next position(s) below the data on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the position right of the data jack.
4 All faceplates installed shall be level.

3.2 LABELING

A. The contractor shall follow the Owner's labeling scheme.
B. Label each cable at its beginning and end points no further than 6" behind termination on a section of cable that is easily accessible. Cable labels shall include the ids of both terminations and cable id.
C. All labels shall be machine printed or embossed. Handwritten labels are not acceptable.
D. All labeling information shall be recorded on the as-built drawings and all test documents.
E. Label all cable beginning and terminating points.
F. Labels for site cables and cables in multiple buildings shall feature the following.
1. Identify origin (MDF or IDF and building), termination (IDF or port identifier), and next pull box.
2. Cables in pull boxes shall have a label at entry into pull box and exit from pull box. Labels shall be stainless steel tags with embossed characters.

3.3 TESTING

A. General
1. All cables (including each fiber) and termination hardware shall be tested.
2. Testing must comply with TIA standards for testing (refer to Section 1.3), plans, specifications, and manufacturer recommendations.
3. Contractor shall notify the Owner or Owner's Representative 72 hours before commencement of testing.
4. Upon receipt of the test documentation, the Customer reserves the right to have the contractor perform a 20% witnessed "spot testing" of the cabling system to validate test results provided in the test document, at no additional cost. If a significant amount of cables are marginal and/or fail during the "spot test" Contractor will retest the entire cable plant at no additional cost.

B. Equipment
1. All equipment must be properly calibrated and traceable to NIST.
2. Equipment shall have been recalibrated within the previous 6 month prior to testing.

C. Data Copper Cables:
1. Each pair in each cable shall be tested in accordance with TIA-568-C series and TIA-TSB-67 for:
a. Opens
b. Shorts
c. Grounds

d. Continuity
e. Polarity
f. DC resistance
g. DC resistance unbalance
h. Impulse noise
i. Signal attenuation
j. NEXT
k. PS-NEXT
l. ELFEXT
m. PS-ELFEXT
n. Return loss
o. Propagation delay
p. Delay skew

2. Each installed cable link shall be tested for installed length using a TDR type device. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number.
3. Conductors and connectors shall be tested as a complete system.
4. Testing of all horizontal cable, outlet ports, patch cords, and riser cable pairs shall include end-to-end tests using a Wavetech Lanteck 100 or Fluke Network's DXT CableAnalyzer Series scanner.
5. Test cables to check that they meet all IEEE and TIA Cat-6a and 10GB/S performance specifications (refer to Section 1.3).
6. All installed cables must meet or exceed the defined standards for performance. The Contractor shall take all steps necessary to repair or replace any optic not meeting the standard.
7. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA standards.
8. The test equipment shall provide a printed document for each test that is also available in a downloadable file using an application from the test equipment manufacturer. The printed test results shall include a print out of all tests performed, and the individual test results for each cable.

3.4 SYSTEM CLOSEOUT AND AS-BUILT DOCUMENTATION

A Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Owner's Representative/Engineer for approval. One (1) to be a hardcopy and two (2) to be electronic copies. Documentation shall include the items detailed in the sub-sections below.

B Documentation shall be submitted within ten (10) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 calendar days of the completion of each testing phase. At the request of the Owner's Representative/Engineer, the telecommunications contractor shall provide copies of the original test results.

C The Owner's Representative/Engineer will request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

D Test Results documentation shall be provided in two media, as listed above, one (1) hardcopy and one (1) on disk within three weeks after the completion of the project. The documentation shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member

name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an bi-annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

E Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package.

F When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.

G The As-Built drawings are to include cable routes, outlet locations and the approved labeling identifiers. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD 2008) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

H Contractor will provide one laminated 11”x17” drawing at each IDF and MDF that includes the building layout for that IDF or MDF, along with the outlet locations and all of the approved labeling.

END OF SECTION

SECTION 272100

ACTIVE NETWORK EQUIPMENT

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section specifies the hardware, software, accessories for, and installation of active network equipment.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A All included sections under Division 1
B All included sections under Division 26
C All included sections under Division 27
D Plans
E Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS AND CODES

A. Governing Codes and Conflicts: If the requirements of the Construction Documents exceed those of the governing codes and regulations, then the requirements of the Construction Documents shall prevail. Where a conflict exists, the governing codes and ordinances shall supersede all other requirements
B. California Electric Code (CEC)
C. Electronic Industries Association (EIA)/ Telecommunications Industries Association (TIA)
   1. EIA/TIA-568-A: Commercial Building Telecommunications Standard
   2. EIA/TIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
D. Institute of Electrical and Electronic Engineers (IEEE)
   1. IEEE 802: Overview and Architecture for Local and Metropolitan Area Networks
   2. IEEE 802.1d: Media Access Control Bridges
   3. IEEE 802.1p: Quality of Service
   4. IEEE 802.1q: Virtual Local Area Networks
   5. IEEE 802.1w: Rapid Spanning Tree Protocol
   6. IEEE 802.1x: Port Based Network Access Control
   7. IEEE 802.1ab: Station and Media Access Control Connectivity Discovery
   8. IEEE 802.1ac: Media Access Control Services Definition
   9. IEEE 802.1ae: Media Access Control Security
   10. IEEE 802.1ar: Secure Device Identity
   11. IEEE 802.1as: Timing and Synchronization for Time Sensitive Applications in Bridged Local Area Networks
   12. IEEE 802.1ax: Link Aggregation
   13. IEEE 802.1ba: Audio Video Bridging
   14. IEEE 802.3: IEEE Standard for Ethernet
   15. IEEE 802.3ad: Link Aggregation
   16. IEEE 802.3ae: 10 Gigabit Ethernet
   17. IEEE 802.3af: Power over Ethernet
   18. IEEE 802.3an: 10 Gigabit Ethernet on Twisted Pair Copper Cable (10G Base T)
   19. IEEE 802.3aq: 10 Gigabit Ethernet on FDDI-Grade Multimode Fiber (10G Base LRM)
   20. IEEE 802.3at: Enhanced Power over Ethernet
   21. IEEE 802.3bt: Physical Layer and Management Parameters for Power over Ethernet over 4 pairs (PoE++/UPoE)
   22. IEEE 802.11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
   23. IEEE 802.11n: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications – Enhancements for Higher Throughput

24. IEEE 802.11ac: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications – Enhancements for Very High Throughput for Operation in Bands below 6 GHz
25. IEEE 802.11ax: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN

E. Underwriters Laboratories, Inc.
1. UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
2. UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
3. UL 2416: Audio/Video, Information, and Communication Technology Equipment Cabinet, Enclosure, and Rack Systems
4. UL 62368-1: Audio/video, information and communication technology equipment - Part 1: Safety requirements
5. UL 60950-1: Information Technology Equipment - Safety - Part 1: General Requirements
6. UL 60950-21: Information Technology Equipment - Safety - Part 21: Remote Power Feeding
7. UL 60950-22: Information Technology Equipment - Safety - Part 22: Equipment to be Installed Outdoors

1.4 QUALITY ASSURANCE

A Equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.

B Supply equipment and accessories new, free from defects.

C Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state, and local codes.

D Items of a given type shall be the products of the same manufacturer.

E Deliver, store, and protect products under provisions of Section 016200.

F Ship equipment in its original packages, to prevent damaging or entrance of foreign matter. Perform handling and shipping in accordance with manufacturer's recommendations. Provide protective covering during construction.

G Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by the engineer.

H Tag items with a weatherproof tag identifying equipment by name and purchase order number. Include packing and shipping lists.

I The work performed under this specification shall be of good quality and performed in a workmanlike manner. In this context ‘good quality’ means the work shall meet industry technical standards and quality of appearance. The Owner reserves the right to reject all or a portion of the work performed, either on technical or aesthetic grounds.

J The Contractor shall provide all necessary materials and labor for a complete, functional Telecommunications cabling infrastructure in accordance with all applicable standards and the Construction Documents.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.

B Submittals shall include the following:
1 Table of contents
2 A complete set of detailed manufacturer’s specifications describing and illustrating all standard and special components and materials
3 Part numbers
4 Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5 Maintenance instructions and intervals
6 A complete set of drawings for any special items

7 A single line block diagram showing exactly the manner in which the contractor proposes to layout the system.
8 Wiring diagrams
9 Illustrations and scale drawing of the racks, equipment layouts etc.
10 Drawings shall include designations, dimensions, operating controls, instruments, riser diagrams, routing diagrams etc.

C Electronic submittals shall be searchable

D The submittal shall be substantially complete for all items and equipment furnished under this section.

E Individual drawings and data sheets submitted at random intervals will not be accepted for review.

F Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.

B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Programming manual
4 Wiring diagrams
5 Trouble-shooting guidelines
6 Voltage ratings
7 Current ratings
8 List of capabilities
9 Environmental ratings
10 NEMA enclosure type
11 Maintenance requirements
12 Installation instructions
13 Repair instructions

C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 SWITCHES

A. All switches shall have the following capabilities, unless otherwise noted:
1. Layer 3 switch
2. Enhanced Interior Gateway Routing Protocol version 6 (EIGRPv6)
3. IEEE 802.1p Quality of Service (QoS)
4. IEEE 802.1q Virtual Local Area Networks (VLANs): 256
5. IEEE 802.1x access control
6. Multiple Spanning Tree Protocol (MSTP)
7. Open Shortest Path First version 2 (OSPFv2)
8. RADIUS authentication
9. Rapid Spanning Tree Protocol (RSTP)
10. Simple Network Management Protocol (SNMP)
11. Two USB ports
12. Password protection
13. Managed switch
14. Power over Ethernet
a. All copper ports shall supply IEEE 802.3at POE+.

b. Minimum available POE power for 24 port switch shall be 720W.
c. Minimum available POE power for 48 port switch shall be 1240W.

15. All ports shall be 10/100/1000 Megabits/second capable.
16. All ports shall be half and full duplex capable.
17. Switch shall include speed and duplex auto-negotiation.
18. Routing table shall be capable of a minimum of 2,000 MAC addresses.
19. Throughput of switch shall be a minimum of 3 Gigabits/second per port.
20. Forwarding
    a. Store and Forward
    b. Cut Through
    c. Fragment Free
21. LED indicators
    a. Port status (each port)
    b. Power
    c. Boot status

B. Switches shall be rated for environment in which they will be installed, including, but not limited to:
   1. Temperature
   2. Humidity
   3. Vibration

C. Models
   1. Cisco #C9300L-48PF-4X-EDU with Cisco #PWR-C1-1100WAC-P and Cisco #PWR-C1-350WAC-P power supplies
   2. Cisco #C9300L-DNA-E-48-3Y license
   3. Cisco #SFP-H10GB-CU1M SFP module

D. All hardware and software shall be registered to the owner.

E. The contractor shall obtain a temporary license for software for installation, programming, and debugging until permanent license is obtained.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The contractor shall securely mount all hardware within the server cabinet/IDF.
B. Make all data connections per the riser diagrams.
C. Make all power connections.
D. Provide and install all software.
E. Program switches so that devices can only communicate with other devices in the same VLAN.

3.2 TESTING

Once all equipment and network have been installed and connected, test the following.

A Test communications and ensure that all devices intended to communicate with each other can communicate with each other.
B Verify correct operation of each switch.
C Verify correct definitions of VLANs.

3.3 DOCUMENTATION

At the completion of the project and before project acceptance, the Contractor must provide “as built” plans, both in hard copy and a CAD format compatible with the Owner’s CAD system.

END OF SECTION

SECTION 275116

PUBLIC ADDRESS AND CLOCK SYSTEM (IP BASED)

PART 1 – GENERAL

1.1 SECTION INCLUDES

This Section includes integrated public address and clock system. It includes requirements for integrated electronic communications network system components including, but not limited to, the following:

A Ceiling/Wall Mounted Speaker Assemblies
B Bell/Class Change Signaling System
C Public Address System
D Administrative Digital Readout Displays
E Controls, Amplifiers, and Terminal Equipment
F Power supplies
G Wall-mounted Paging Horns
H Program Sources – Tuner, CD, MP3
I Clocks

1.2 RELATED WORK SPECIFIED ELSEWHERE

A All included sections under Division 1
B All included sections under Division 26
C All included sections under Division 27
D Plans
E Manufacturers' manuals, product bulletins, etc.

1.3 REFERENCE STANDARDS

Published specifications standards, tests or recommended methods of trade, industry or government organizations apply to work in this section as cited in Section 260000.

A. CEC: California Electrical Code
B. NFPA: National Fire Protection Agency
    1. NEC: National Electrical Code
C. Underwriters Laboratories, Inc.
    1. UL 50: Enclosures for Electrical Equipment, Non-environmental Considerations
    2. UL 50E: Enclosures for Electrical Equipment, Environmental Considerations
    3. UL 1690: Standard for Data-Processing Cable
    4. UL 1863: Communications Circuit Accessories
    5. UL 1977: Component Connectors for Use in Data, Signal, Control, and Power Applications
    6. UL 2024: Standard for Signaling, Optical Fiber and Communications Raceways and Cable Routing Assemblies
    7. UL 2416: Audio/Video, Information, and Communication Technology Equipment Cabinet, Enclosure, and Rack Systems
    8. UL 2572: Control and Communication Units for Mass Notification Systems
    9. UL 62368-1: Audio/video, information and communication technology equipment - Part 1: Safety requirements

1.4 QUALITY ASSURANCE

A Equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
B Supply equipment and accessories new, free from defects.
C Equipment and accessories in compliance with the applicable standards listed in Article 1.3 of this section and with applicable national, state, and local codes.
D Items of a given type shall be the products of the same manufacturer.

E Installation and start up of the system shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers and be prepared to offer a service contract for system maintenance on completion of the guarantee period.

F The agency providing equipment shall be responsible for providing all specified equipment and mentioned services for all equipment as specified herein. The agency must be an authorized distributor of specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory-trained technicians for all of the specified equipment. The agency must have established business for and currently be providing all services for the equipment to be provided for a minimum of five (5) years.

G The contractor shall guarantee availability of service by factory-trained personnel of all specified equipment from the authorized distributor of all equipment specified under this section. On-the-premise maintenance shall be provided at no cost to the purchaser for a period of one (1) year (parts and labor) from date of acceptance unless damage or failure is caused by misuse, abuse, neglect, or accident. Additionally, products are covered by a five (5) year (parts only) limited warranty from the date of acceptance. The warranty period shall begin on the date of acceptance by the owner/engineer.

H The contractor shall, at the owner's request, make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

I Provide complete and satisfactorily operating Integrated Intercom/Communications System as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturer's standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

1.5 SUBMITTALS

A Submit under provisions of Section 013000 or 013300.

B Submittals shall include the following:

1. Table of contents
2. A complete set of detailed manufacturer's specifications describing and illustrating all standard and special components and materials
3. Part numbers
4. Evidence of compliance with the applicable standards listed under Article 1.3 of this section
5. Maintenance instructions and intervals
6. A complete set of drawings for any special items
7. A single line block diagram showing exactly the manner in which the contractor proposes to layout the system.
8. Wiring diagrams
9. Illustrations and scale drawing of the racks, equipment layouts etc.
10. Drawings shall include designations, dimensions, operating controls, instruments, riser diagrams, routing diagrams etc.

C Electronic submittals shall be searchable

D The submittal shall be substantially complete for all items and equipment furnished under this section.

E Individual drawings and data sheets submitted at random intervals will not be accepted for review.

F Substitutions: Items of same function and performance shall be submitted in conformance with Division 1.

1.6 OPERATION AND MAINTENANCE MANUALS

A Submit operation and maintenance manuals in accordance with Section 260000.
B The manuals shall, at minimum, include the following:
1 Manufacturer (including contact information)
2 Model number
3 Programming manual (where applicable)
4 Wiring diagrams
5 Trouble-shooting guidelines (where applicable)
6 Voltage ratings
7 Current ratings
8 Calibrated range (where applicable)
9 List of capabilities
10 Environmental ratings
11 NEMA enclosure type
12 Maintenance requirements
13 Installation instructions
14 Repair instructions (where applicable)
C Provide manuals in one of the following formats
1 Three hardcopies
2 PDF

PART 2 – PRODUCTS

2.1 BASIC SYSTEM

A The system shall provide secondary automatic audio distribution of program tone signals, audio programs, public address, paging by zones with emergency announcement override. Input to the public address and paging functions of the system shall be provided by a direct interface to the Owner's telephone system.
B Features offered by this system shall be implemented and controlled by software programs that can be changed and expanded as customer needs evolve.
C The system shall allow system monitoring and administration from a local Windows network.
D The system shall be an IP system consisting of speakers and clocks.
E The system shall have the ability to provide multiple zone program distribution which is not interrupted by intercom communications.
F The system shall lend itself to expansion using the software.
G The system shall provide two-way communication between any telephone and any room speaker.
H Room speakers shall be programmable. They shall be capable of being assigned any three, four, or five digit number. Any room number may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.
I Sixteen (16) separate paging zones shall be provided; each location shall be programmed in software to belong to any combination of software zones. Initially, zones shall be provided for the following:
1 One zone for inside classroom speakers grades 1 through 2
2 One zone for inside classroom speakers grades 3 through 4
3 One zone for inside classroom speakers grades 5 through 6
4 One zone for gymnasium speakers
5 One zone for cafeteria speakers
6 One zone for corridor speakers
7 One zone for common areas
8 One zone for administrative areas
9 One zone for teachers' lounge and workrooms
10 One zone for outside speakers

J Each phone system shall be capable of interfacing with the PA system and be programmable for the following options:
1 Allow zone paging
2 Allow All-Page announcements
3 Allow Executive Override
4 Allow Emergency paging
5 Allow activation of Time Zone tones
6 Set the priority level and target display of "normal" calls
7 Set the priority level and target display of "emergency" calls
8 Assignment of architectural number
9 Class of Service
10 Assignment of associated speaker to paging zone
11 Automatic Call-Back-Busy
12 Call Forward-No Answer
13 Call Forward-Busy
14 Allow activation of security monitoring functions on a per-room and per-zone basis

K Amplified two-way voice communication shall be available from any dial phone in the system, through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active.

L The system shall allow room or area security monitoring features. This will include the ability to support motion detectors or normally open alarm inputs.

M All hardware and software shall be registered to the owner.

N The contractor shall obtain a temporary license for software for installation, programming, and debugging until permanent license is obtained.

2.2 EQUIPMENT RACK

A. Mount public address system head end equipment in the existing MDF.

B. Mount PA/clock ethernet switches in the existing IDFs and MDF.

2.3 HEAD END EQUIPMENT

A. The public address head end equipment shall consist of the following.
1. Rauland-Borg #TCC2000 campus controller
2. Rauland-Borg #TCU3000SW campus controller license
3. Rauland-Borg #TCC2045 administrative console
4. Rauland-Borg #TCC2055 line input module and Rauland-Borg #TCC2033 input/output module mounted in a Rauland-Borg #TCC2099 rack mounting bracket

B. The clock head end equipment consists of an existing NTP server accessed through the campus controller.

2.4 CLOCK AND SPEAKER ASSEMBLIES

A Interior speakers next to clocks in classrooms and administration areas shall consist of the following.
1 Rauland-Borg #ACC1480 speaker
2 Rauland-Borg #TCC2011A IP interface
3 Rauland-Borg #TCC3011S clock/message board
4 Rauland-Borg #ACC3011SBB surface mounted backbox
5 Rauland-Borg #ACC3011S speaker and clock baffle assembly

B Interior horns next to clocks in cafeterias, gyms, and multi-purpose rooms areas shall consist of the following.
1 Horn

a Lowell Manufacturing #VRG-LUH15TX horn with vandal resistant grille set to 7-1/2W.
b Lowell Manufacturing #CB86-SGVPO exterior backbox
c Rauland-Borg #TCC3022 zone paging amplifier – one amplifier may be used to power multiple speakers in the same room as long as speaker wattage does not exceed TCC3022 capacity.
d Rauland-Borg #TCC3022PS power supply

2 Clock
a Rauland-Borg #TCC3012L clock/message board
b 2-gang, steel, surface mount backbox
c Safety Technology International #STI-VFC01 protective cover

C Interior speakers individually mounted shall consist of the following.
1 Rauland-Borg #ACC1480 speaker
2 Rauland-Borg #TCC2011A IP interface
3 Rauland-Borg #ACC1112 backbox
4 Rauland-Borg #ACC1003 baffle

D Exterior speakers shall consist of the following.
1 Lowell Manufacturing #8C10MRB moisture resistant speaker
2 Rauland-Borg #ACC1113 backbox
3 Rauland-Borg #ACC1012 vandal resistant grille
4 Rauland-Borg #TCC2011A IP interface
5 Rauland-Borg #603101 wire breakout

E Exterior horns facing playgrounds, sports fields, and large parking lots shall consist of the following.
1 Lowell Manufacturing #VRG-LUH15TX exterior horn with vandal resistant grille
2 Lowell Manufacturing #CB86-SGVPO exterior backbox
3 Rauland-Borg #TCC3022 zone paging amplifier – one amplifier may be used to power multiple horns in the same zone as long as horn wattage does not exceed TCC3022 capacity.
4 Rauland-Borg #TCC3022PS power supply

2.5 CABLE AND CONDUCTORS

A. Refer to Section 271000 for Cat-6A cable requirements.

B. Cables from zone paging amplifiers to speakers shall be one of the following.

1. Interior, non-plenum rated: West-Penn 357 or approved equal
   a. UL Listed NEC Type CMR or CL3 constructed in accordance with UL Standards 13, 444, & 1666.
   b. One 22AWG UTP and one 22AWG STP
   c. Two (2) conductors are for connection to the speaker and two (2) conductors are spares.
2. Interior, plenum rated: West-Penn 25357B or approved equal
   a. UL Listed NEC Type CMP or CL3P constructed in accordance with UL Standards 13, 444, & 1666
   b. One 22AWG UTP and one 22AWG STP
   c. Two (2) conductors are for connection to the speaker and two (2) conductors are spares.
3. Underground: West-Penn AQC357 or approved equal
   a. UL Listed NEC Type CM or CL3 constructed in accordance with UL Standards 13 and 1685
   b. One 22AWG UTP and one 22AWG STP
   c. Two (2) conductors are for connection to the speaker and two (2) conductors are spares.

PART 3 – EXECUTION

3.1 EQUIPMENT

A. The IDF/MDF shall contain the Program Unit and power supplies and other associated equipment or devices necessary for supporting the entire system.

3.2 CLOCKS AND SPEAKERS

A. Speakers shall be installed where shown on the drawings.
   1. Verify mounting heights and exact locations of interior clocks and speakers as they relate to doors, windows, cabinets, white boards, tack boards and other interior elevations with the Architect prior to installation.
   2. Verify mounting heights and exact locations of exterior speakers with the Architect prior to installation.

B. Verify mounting heights and exact locations of speakers as they relate to doors, windows, cabinets, white boards, tack boards and other interior elevations with the Architect prior to installation.

C. Verify mounting heights and exact locations of exterior speakers with the Engineer prior to installation.

D. Adjust wattage of exterior horns so that speech is intelligible onsite but not loud at the property line.

E. Install IP interface on mounting bracket of Rauland-Borg speakers.

F. Install IP interface in back box for speakers by other manufacturers. Make sure IP interface is a minimum of 6” from the speaker’s magnet.

3.3 CONDUIT, CABLE, AND CONDUCTORS – INSTALLATION

A. Inside Buildings: Cable and conductors shall be routed in conduit run overhead and parallel to the structure.
   1. Conduit shall be rigid steel, IMC or EMT as described elsewhere in these specifications.
   2. Plastic conduit shall not be used above grade.
   3. Plenum rated cable may be used behind accessible T-bar ceilings only. Mount cable at the roof joist (or bottom of floor above) on "J-hooks" at every 8'-0" or less. Support each cable within 1'-0" of its termination point. Run cable parallel to the building structure and provide mechanical support for vertical runs by using Unistrut channel securely fastened in place.
   4. Cable and conductors shall not be attached to the support wire of the T-bar ceiling or laid across the ceiling boards.

B. Between buildings: Cable and conductors shall be routed in conduit run underground.
   1. Conduit shall be rigid steel, IMC, or plastic as described elsewhere in these specifications.
   2. The use of EMT is not acceptable.

C. On The Roof: Conduit shown on the drawings as being on the roof of the building or covered walkway shall be installed on 4" by 4" wood blocking (sleepers) attached to the structure every 8'-0" or less.
   1. Conduit shall be rigid steel or IMC as described elsewhere in these specifications.
   2. The use of EMT or plastic conduit is not acceptable.

D. Terminations:
   1. Terminations shall be made at the patch panel indicated per the riser diagrams. Utilize data quick port female jacks within the IDF/MDF. The ports shall match those being used for the telephone VoIP or Data outlets.

3.4 LABELING

A Label all conductors, conduit, terminal blocks, patch panels, modular jacks, outlets, and any termination point associated with the cable installation.

B Follow the Panduit Company “Labeling Guide for ANSI/TIA/EIA-606” manual and use the products specified therein.

3.5 TESTING

A All copper cables shall be tested for opens, shorts, grounds, continuity, polarity, DC resistance, impulse noise, and signal attenuation.

B Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 FIELD QUALITY CONTROL

A Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

3.7 COMMISSIONING

A Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Provide a minimum of 8 hours training. Operators Manuals and Users Guides shall be provided at the time of this training.

B Schedule training with the district with at least seven days advance notice given to the Owner so they may invite district faculty and personnel.

3.8 CLEANING AND PROTECTION

Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION