

PART 1 – GENERAL

1.1 REFERENCE STANDARDS

- A. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- B. UL 845 - Motor Control Centers; Current Edition, Including All Revisions.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary conditions, Divisions 0 and 1 and Section 26 6000 specifications apply to work of this section.

1.3 SCOPE OF WORK

- A. This portion of the work includes the furnishing of all labor and materials necessary for the complete wiring system to outlets and all equipment shown on the drawings or covered by this Section of the Specifications and other Division 26 and Division 28 sections of the Specifications. In general, the work includes the following:
 - 1. Complete system of branch circuit wiring, conduit and distribution equipment for lights, receptacles, and power.
 - 2. Furnish and install lighting panelboards, lamps, lighting fixtures, wall switches, convenience outlets, etc. as shown on drawings.
 - 3. All hangers, anchors, sleeves, chases, and supports for fixtures, all electrical equipment and materials.
 - 4. Furnish, install, and connect wire, conduit, and switches, etc. required for other equipment covered by other sections of these Specifications.
 - 5. All excavating and backfill as required for electrical work.
 - 6. The patching and repair of all work modified or damaged by the installation of work under this Contract.
 - 7. Outlet boxes and conduit system for telecommunications (voice and data).
 - 8. Demolition work.
 - 9. Terminal cabinets and backboards.

10. The Contractor shall furnish and install all work necessary to make complete systems, whether or not such details are mentioned in these Specifications or shown on the drawings, but which are necessary in order to make complete working systems, excepting only those portions that are specifically mentioned therein or plainly marked on the accompanying drawings as being installed by other Contractors.
11. Electrical Contractor must coordinate his work with the work of other trades so as to provide raceways, conductors and outlets in the correct location for the equipment served, including all built-in appliances, mechanical, and signal equipment and connect same. Electrical Contractor must provide power of the correct voltage and phase to each item of equipment.
12. Before construction starts, the Electrical Contractor shall arrange a coordination meeting with the General Contractor and all other subcontractors supplying equipment that requires electrical connections. All electrical requirements shall be verified, and any problems shall be immediately reported to the Architect. Equipment items to verify shall include, but not be limited to: Voltage, amps, phase, location, orientation, space requirements, type of connection, starter and disconnect location and provision, control system operation and requirements, etc.
13. The above list is given for the convenience of the Contractor and is not considered all-inclusive.
14. Complete system of conduits, substructures and equipment for power, telephone, and cable television services. The Electrical Contractor shall inform the respective utility companies that the project has been started and confirm that all forms, which are required for the Application for Service, have been completed and submitted to the Utility Company. The Electrical Contractor shall obtain a copy of the approved engineering drawings prior to construction.

1.4 TEMPORARY CONSTRUCTION POWER

- A. Provide a temporary construction power system that is adequate for this project. Coordinate requirements and details with the General Contractor. All 120V, 15A and 20A receptacles shall have ground fault circuit interrupter protection.

1.5 WORK NOT INCLUDED

- A. A. The furnishing and installation of motors.
- B. Access panels.

1.6 COORDINATION WITH MECHANICAL WORK

- A. The Mechanical Contractor shall furnish equipment such as motors, starters, thermostats, wiring diagrams, etc. However, the Electrical Contractor shall be responsible for furnishing and installing of all fused disconnect switches, conduits, wire, fittings, etc. for power connections.
- B. Install all electrical equipment where it is not already installed as a part of a unit furnished by the Equipment Contractor. (See drawings of respective contractors).
- C. The Electrical Contractor shall furnish fused disconnect switches for pumps, motors and air conditioning and handling units, if they are not furnished by others. Fuses shall be dual element, rating per equipment manufacturer's recommendations. Disconnects shall comply with requirements for "Motor Disconnects" as specified earlier in this section.
- D. All disconnect switches (whether provided with unit or by Contractor) shall have a circuit identification engraved nameplate as specified under "Motor Disconnects".
- E. Thermal overload protection shall be furnished for all motors where such protection is not included as a part of another contract.
- F. All motor outlets, disconnect switch locations and control outlets shown on the plans are approximate only. Verify exact location of same with Equipment Contractor.
- G. All line and low voltage controls, including conduits, outlets, wiring and connections shall be furnished and installed by the Mechanical Contractor. (Division 23).
- H. Furnish and install a weather-resistant duplex receptacle with ground fault circuit interrupter protection within 25 ft. of all rooftop H.V.A.C. units. Provide a diecast weatherproof "while-in-use" lockable cover, Red Dot #CKSUV or equal.
- I. Coordinate with General Contractors, Mechanical Contractors and equipment suppliers before bid is submitted and again before rough-in is started to verify that all systems are complete and all components are provided including starters, disconnects, relays, solenoids, control conduit and wire, etc.

PART 2 - MATERIALS

2.1 GENERAL

- A. All materials, appliances, and equipment except that furnished by the Owner shall be new, bear U.L. Label and of the make, brand or quality specified or as accepted by the Architect as herein provided. This shall also apply to all parts of the work whether or not this particular paragraph is referred to by number.

- B. All apparatus, conduit systems, etc., shall be installed and interconnected so as to form complete systems as herein specified and/or shown on all the accompanying drawings. This Contractor shall furnish and install all work necessary to make complete working systems, excepting only those portions that are specifically mentioned herein or plainly marked on accompanying drawings as being furnished by other contractors.

2.2 MAIN SWITCHBOARD

- A. Dead front, dead rear, floor standing, consisting of underground pull section, main section with main circuit breaker and equipment to accommodate power company's current transformer and meter, distribution section and sub-feed circuit breakers as shown on drawings. Main switchboard shall be as manufactured by Square D, General Electric, Eaton, Siemens or approved equal.
- B. Circuit breakers shall be molded case type, quick-make, quickbreak, with thermal magnetic trip. Size and rating shall be as shown on the drawings. All circuit breakers shall be bolt-on type. Two and three pole breakers shall have integral internal common trip. All circuit breakers, rated 100 amps and larger, shall be equipped with adjustable instantaneous trip settings.
- C. Finish shall be one coat of rust-inhibiting primer and two coats of gray enamel.
- D. Full-size buses shall extend the full height of the distribution section. A copper ground bus shall be provided firmly secured to each vertical section structure and shall extend the entire length of the switchboard.
- E. Section or sections shall be fully bussed with either copper or tin-plated aluminum bussing with all hardware in place for future devices. The bussing shall be braced to withstand the fault current of 50,000A symmetrical minimum. Filler plates as required shall be supplied with two handles on each plate. Sub-feed devices shall be of the types indicated on the drawings and shall be lockable in the "Open" position. A nameplate shall be supplied for each device in each section of each switchboard affixed to the switchboard trim adjacent to device and indicating name of device as shown one line diagram. Black letters shall be minimum $\frac{3}{4}$ " high on white background.
- F. All circuit breakers in the main switchboard shall have short circuit current interrupting capacity exceeding the maximum available at service transformer. Contractor shall be responsible for obtaining fault current information from serving Utility Company prior to fabrication of main switchboard. The main switchboard shall have an integrated short circuit current interrupting rating of a minimum of 30,000A symmetrical, or greater if indicated on drawings.

- G. Underground pull sections shall be manufactured by the same manufacturer of the switchboard and per the serving Utility Company's requirements.
- H. The Electrical Contractor shall submit three (3) copies of the main switchboard shop drawings to the Serving Utility Company for their approval prior to fabrication of the main switchboard.

2.3 PANELBOARDS

- A. The panelboards shall be constructed in accordance with the standard set up by the Underwriters' Laboratories, Inc., and as manufactured by Square "D", General Electric, Eaton, Siemens or approved equal, and each shall contain the number and type of circuit breakers as indicated on the drawings. All circuit breakers, rated 100 amps and larger, shall be sub-feed type and equipped with adjustable instantaneous trip settings.
- B. The panelboards shall be equipped with a hinged lockable door, piano hinged trim, and typewritten circuit directory. All finish in offices, corridors, or areas subject to public view shall be prime coat for finish coat by painter. In storage rooms, equipment rooms, etc., finish shall be standard factory gray Hammertone. Provide a flush lock on all panelboards.
- C. Provide an engraved Bakelite nameplate, fastened with screws or rivets to the face of each panelboard, which will identify it.
- D. Any panel with an isolated ground bus shall have a nameplate stating, "IG CIRCUITS". Nameplate to be same size and color and adjacent to panel designation nameplate.
- E. Seven copies of detailed construction drawings for the panelboards and terminal cabinets shall be submitted to the Architect for Approval before their construction is started.

2.4 MAGNETIC STARTERS

- A. Motor Starters shall be across-the-line magnetic type rated in accordance with NEMA Standards, sizes, and horsepower ratings, mounted in general purpose enclosures, or NEMA 3R as required. All starters shall be full voltage, non-reversing, unless otherwise noted. Thermal overload relays on starters shall be non-compensated bimetallic type with selector for either auto or manual reset. Overload heater units shall be provided in each leg of starter unit. Each starter shall have 2 auxiliary interlock contacts.
- B. Each starter shall have 120-volt control transformer and HOA selector switch mounted on cover.

- A. Terminal cabinets shall be flush, or surface mounted as indicated with hinged doors and lock. The exterior finish to be same as for panelboards. Provide $\frac{3}{4}$ " plywood backing inside of cabinet. Provide proper number of terminals in cabinets as required.
- B. Provide a Bakelite nameplate fastened with screws or rivets to the face of each terminal cabinet, which will identify it.
- C. Provide circuit directory and holder on inside of door with one line for each conductor entering and each conductor leaving cabinet.

2.6 RACEWAYS AND FITTINGS

- A. Shall be manufactured by Allied Tube and Conduit Corporation, AFC Cable Systems, Inc., Carlon, Cantex, PW Pipe or approved equal.
- B. Galvanized rigid steel conduits (RSC) may be used in all locations.
- C. For underground runs in direct contact with earth, conduit shall be wrapped with PVC tape or shall have factory applied PVC coating.
- D. Galvanized intermediate metallic conduit (IMC) may be used in indoor locations not in direct contact with earth.
- E. Galvanized electrical metallic tubing (EMT) may be used in indoor dry locations in which it is:
 - 1. Not subject to physical damage.
 - 2. Not in direct contact with earth.
 - 3. Not in concrete slabs.
 - 4. Not in hazardous areas.
 - 5. On roof or walk cover when specifically shown on drawings.
 - 6. In masonry walls, not in the same cells as rebars.
- F. Non-metallic rigid conduit shall be PVC Schedule 40 and may be used:
 - 1. Underground.
 - 2. Below concrete slab on grade.
 - 3. In concrete slab on floors above grade.

4. In masonry walls, not in same cells as rebars.
- G. Flexible steel conduit may be used in dry locations for final connections to:
 1. Motors, transformers, and other mechanical equipment, not to exceed 18 inches.
 2. Lighting fixtures, not to exceed 72 inches.
 3. Facilitate wiring in tight locations, when approved by Engineer.
- H. Flexible aluminum conduit may be used in walls or in attics to facilitate wiring in tight locations, when approved by the Engineer.
- I. Liquidtight flexible steel conduit shall be used in outdoor or wet locations for final connection to motors or other mechanical equipment, not to exceed 18 inches.
- J. Fittings:
 1. For rigid and intermediate steel conduits, fittings shall be:
 - a. Galvanized rigid steel threaded type.
 - b. Provide insulated grounding bushings at switchboard enclosures and panel enclosures for feeders.
 2. For electrical metallic tubing (EMT), fittings shall be:
 - a. Zinc plated steel set screw type in dry locations.
 - b. Zinc plated steel compression type for conduits larger than 1", in wet locations and in masonry walls.
 - c. All connectors shall have an insulated throat.
 3. For non-metallic conduits, fittings shall be PVC Schedule 40 type. Use PVC schedule 40 adapters at all boxes and panelboards.
 4. Brush or dauber apply PVC cement.
 5. For flexible metallic conduits, fittings shall be zinc plated steel/malleable iron squeeze type.
 6. For liquidtight flexible metallic conduits, fittings shall be zinc plated steel/malleable iron compression type.
 7. Use of the following is prohibited:

- a. Crimp-on, tap-on or indenter type fittings.
- b. Spray (aerosol) PVC cement.

2.7 PULL BOXES

- A. Pull Boxes shall meet all code requirements as to size for conduits terminating therein and to thickness of material used in fabrication.
- B. Fabricated sheet steel pull boxes shall be installed only in dry, protected locations and shall be furnished with knockouts and removable screw cover. The box shall be finished with one coat of zinc chromate and a coat of primer sealer and where exposed to public view shall be painted to match the surrounding surface.
- C. Weatherproof sheet steel pull boxes shall be fabricated of code gauge galvanized sheet steel with two coats of rust resistant finish and shall be furnished with gasket and made completely weathertight.
- D. Approved manufacturers for metal boxes are Cooper B-Line, Milbank, Hoffman or approved equal.
- E. Weatherproof concrete pull boxes, junction boxes and telephone boxes shall be manufactured by Christy Concrete Products, Utility Vault or approved equal. All pull boxes shall be H/20 rated and be equipped with H/20 rated galvanized steel checker plate cover with the inscription "Electric, Lighting, Fire Alarm or Signal".

2.8 TIME SWITCHES

- A. Time switch shall be a two-circuit digital time clock with photo control input, battery back-up and a surface enclosure. Provide a flush enclosure when indicated. Tork #DGLC (120V) or DGLC-3 (277V) or approved equal.

2.9 OUTLET BOXES

- A. All outlet boxes shall be standard one or two piece galvanized knockout outlet boxes. Raco, Appleton, Thomas and Betts or approved equal.
- B. All outlet box covers, rings or other fittings shall be standard galvanized. Raco, Appleton, Thomas and Betts or approved equal.
- C. No outlet box shall be smaller than four inches (4") square and 1 ½" in depth, except in concrete block construction where Thomas and Betts concrete masonry boxes are approved.
- D. Floor outlets on grade shall be fully adjustable type floor boxes, suitable for use in concrete floors. Wiremold #RFB6E-OG with a Wiremold #8CTC2NKTR Evolution

cover assembly. Where floor box is installed in a bare concrete floor, provide a Bare Concrete and Terrazzo ring, Wiremold #RFB6E-CTR with a Wiremold #8CT2NKTR Evolution cover assembly.

- E. Cover shall be die-cast aluminum with nickel finish, unless otherwise noted on drawings. For 120V power, provide an industrial specification grade 20A 125V duplex receptacle with internal duplex receptacle bracket #RFB6DP, quantity as shown on drawings. For data/telephone, provide a decorator style receptacle bracket #RFB6GFI for mounting frame to accept the modular telephone/data jacks, unless otherwise noted on drawings. Any unused device compartments shall be covered with internal blank bracket #RFB6B.
- F. All special outlets shall be as hereinafter specified or as shown on drawings.
- G. Thru boxes are not permitted.
- H. Any unused boxes shall be equipped with a blank cover plate.

2.10 RECEPTACLES

- A. Furnish and install an industrial specification grade 20A, 125-volt, 3 wire grounding type tamper-resistant duplex receptacle with one piece brass mounting strap at all receptacle outlets as indicated on drawings. Leviton #5362-SGW or equal as manufactured by Hubbell, Pass and Seymour, Eaton, or other approved manufacturers.
- B. Device color shall be white.
- C. Tamper-resistant isolated ground duplex receptacles shall be 20A, 125V NEMA 5-20R, orange in color. Leviton #T5362-IG or approved equal.
- D. Tamper-resistant G.F.C.I. duplex receptacles shall be provided for 15 and 20-amp 125-volt circuits where required by the C.E.C. #210.8 and #590.6. At indoor locations, provide Leviton #G5362-OTW or equal. At exterior locations, provide weather and tamper-resistant type G.F.C.I. duplex receptacles, Leviton #G5362-WTW or equal. At damp locations, provide a diecast weatherproof lockable cover, RACO # 5028-0 or equal. At wet locations, provide a diecast weatherproof "while-in-use" lockable cover, Red Dot #CKSUV or equal.

2.11 LOCAL SWITCHES

- A. Furnish and install industrial specification grade, quiet type toggle switches, 20 AMP rated 120/277V AC only, controlling wall and ceiling outlets as indicated on the drawings. Leviton #1221-2W or equal as manufactured by Hubbell, Pass and Seymour, Cooper or other approved manufacturers.

- B. Where two or more switches are in proximity they shall be ganged in the same box, and they will be set under one plate. Switches controlling lights and/or outlets on emergency power shall be kept entirely independent of all other switches not on emergency power by mounting in a separate box.
- C. Special receptacles or switches shall be as noted on the drawings.
- D. Where key switches are noted on the drawings, provide Leviton #1221-2KL.
- E. Device color shall be white.
- F. When a switch is used as a disconnecting means, it shall be mounted in a readily accessible location.

2.12 WALL PLATES

- A. All wall plates for electrical outlets and devices shall be smooth stainless steel, non-magnetic type 302S.
- B. All telephone outlet plates shall be blanked plates, same as device plates.

2.13 CONDUCTORS (WIRE)

- A. All wire installed in this contract shall be of a standard manufacturer as approved by the National Board of Fire Underwriters and be of the size as indicated on the drawings. All wire shall bear the Underwriters' label and shall be brought to the job in unbroken packages and approved by the Job Inspector before it is installed.
- B. All power conductors #10 AWG and smaller shall be type THWN copper, unless otherwise noted. All conductors #8 AWG and larger shall be type THWN-2 copper, unless otherwise noted.
- C. All underground conductors in a 480V or 480/277-volt power system shall be type XHHW-2 copper, unless otherwise noted.
- D. Number 12 AWG wire shall be the smallest gauge wire used, except for signal circuits, which shall be as shown on plans or as specified under other sections of these specifications.
- E. All wire #8 AWG gauge or larger shall be stranded.
- F. The neutral conductor of all lighting feeders shall be of the same size as the phase conductors.
- G. Splices on all wire less than #8 gauge shall be with insulated spring connectors Ideal "Wing Nuts", 3M "Scotchlok", or equal.

- H. Splices in wires #8 gauge and larger shall be made with crimp on solderless connector, 3M Scotch, Burndy or equal. Connectors to switches or bus bar shall be made with one-piece lugs for all wires, sized for conductors as shown on the plans.
- I. Each branch circuit shall be marked with the circuit number at the panel and at the first outlet nearest the panel. E-Z Code Markers (Thomas and Betts) or equal shall be used to label the circuits.

2.14 LIGHTING FIXTURES

- A. This Contractor shall submit for approval electronic portfolios, PDF format, with full description and manufacturer data sheets of all fixtures (including ballasts and lamps), that he proposes to use.
- B. This Contractor shall furnish and install all lighting fixtures and lamps as indicated on the Electrical Drawings and in accordance with these specifications.
- C. This Contractor shall be held responsible for the complete equipment of all fixture outlets with fixtures of the proper design as shown.
- D. All fixtures shall be securely anchored to prevent any possible chance of their falling.
- E. Continuous runs of fixtures shall be installed straight and true.
- F. Recessed fixtures shall be complete with plaster frames, supporting brackets and hanger wires.
- G. Stem lengths shall be adjusted to meet conditions where required. Furnish aligners to ensure vertical alignment (ball aligner).
- H. Electrical Contractor shall coordinate outlets with Acoustic Tile Contractor and other trades and locate outlets in the center or at intersections of acoustical tile in all acoustical tile ceilings.
- I. Recessed fixtures in t-bar ceilings shall be attached to t-bar ceiling with integral
- J. t-bar clips, two at each end of fixture.
- K. When the light fixture is equipped with an integral emergency battery pack, the light fixture shall be connected so that it is controlled via the room light switch and is automatically energized when power has fails.

2.15 PHOTO CONTROL

- A. Paragon or equal, adjustable type.

- A. Disconnects shall be fused safety switches with dual element fuses. Heavy Duty rated with quick-make, quick-break operating mechanism. Fuse rating shall comply with motor manufacturer's recommendations. Switch shall be UL listed.
Disconnects shall have an external operating handle, lockable in the open or closed position.
- B. Disconnect switches shall be located so as not to obscure any part of the HVAC unit's nameplate data.
- C. Each disconnect switch shall have an engraved Bakelite nameplate identifying the panel and circuit number that feeds the motor. Nameplates shall comply with specifications for "Identification of Switches and Apparatus".

2.17 DRY TYPE TRANSFORMERS

- A. Transformer shall be Class H insulation with temperature rise not exceeding 115 degrees C., in a maximum ambient of 40 degrees C., with rated nameplate load connected to the secondary side, at rated voltage. Unless otherwise noted, the transformer shall comply with the Energy Efficiency levels mandated by the Department of Energy.
- B. Transformer shall be built in accordance with the latest revised IEEE, ANSI and NEMA standards.
- C. Case temperature shall not exceed 35 degrees C., above ambient.
- D. Designs shall incorporate built-in vibration dampening systems.
- E. Terminal compartment shall be located to ensure termination of cable leads in temperature levels not to exceed 60 degrees C., and to provide for side or bottom entrance of conduit. Enclosures shall be weatherproof and rodent proof.
Ventilation openings shall be louvered type. Screening will not be acceptable.
- F. Transformer shall be furnished with 2 taps above and below rated voltage, each 2 ½%.
- G. Transformer shall be suitable for non-linear loads and have a U.L. rating of K-4, when indicated on the drawings.
- H. Acceptable manufacturers shall be Square "D", General Electric, Eaton, Siemens or approved equal.

- A. When telephone cables are indicated on drawings, they shall be Category 3, 24 AWG, unshielded twisted pairs with 4 pairs minimum, COMMScope #3504 or equal. If in a plenum, use plenum rated cable, COMMScope #35N4 or equal.

PART 3 - EXECUTION AND INSTALLATION

3.1 CONDUIT SYSTEMS

- A. A concealed conduit system shall be installed for all interior wiring including controls. Conduit shall be run continuously between outlets, etc., and with the minimum number of bends.
- B. PVC 40 shall be used for underground runs.
- C. Where underground conduit cannot be run below building footings and the Contractor shall provide PVC-80 sleeves through the footings (Contractor shall obtain approval for all sleeve sizes and locations with the Structural Engineer before installation).
- D. All conduit shall be delivered to the site of construction in their original bundles. Each length of conduit shall bear the label of the National Board of Fire Underwriters. All conduit subjected to rough usage while on the job before installation and not acceptable to the Architect shall be removed from the premises upon notice.
- E. Conduit installed in masonry walls shall be rigid steel galvanized conduit, PVC or EMT, not in same cell as re-bars.
- F. The joints in all conduits installed under concrete slabs on the ground, or underground, or exposed to the weather, shall be made liquid and gas tight. All underground conduit outside of the buildings shall be buried to a depth of not less than 24" below finish grade. Utility services shall comply with utility company requirements. Two or more conduit runs installed in a common trench shall be separated horizontally by at least four inches (4"). Electrical conduit runs installed in a common trench with other utility lines shall be separated horizontally from such lines by at least twelve inches (12"). Provide a detectable warning tape, 12" above the top of the conduit and the full length of trench.
- G. Changes in direction shall be made with conduit elbows or long radius bends made on the job. Where two or more conduits are grouped in exposed locations, the sweeps shall be struck from the same center forming concentric arcs.

- H. All joints in conduit shall be made with standard coupling. In making joints, conduits must be truly and accurately cut and threaded (where applicable) with straight thread, smoothly reamed and squarely butted. All conduit shall be kept corded and dry during construction, using plastic caps or conduit pennies held in place with conduit bushings. Should dirt or moisture collect in any conduit, the Contractor shall swab them out to the satisfaction of the Architect.
- I. Conduits ending at the motors shall be carried as close as possible to the terminal blocks making allowance for the movement of the motors when they are equipped with slide rails. The connection between the conduit terminals on the motor and the conduit shall be made with liquid-tight flexible conduit using the proper fittings.
- J. All conduits where they enter panel enclosures, pull boxes, or outlet boxes shall be secured in place by galvanized locknut inside of box.
- K. Where conduits are run exposed, they shall be installed straight and true with reference to the adjacent construction.
- L. Any conduit installed under the building shall be under the slab. The top of any conduit below floor slab shall be a minimum of 4" below the bottom of the concrete slab.
- M. All boxes for bracket outlets shall be equipped with a 3/8" "No-Bolt" fixture stud. These boxes shall be so set that when in place the fixture shall be at right angles to the ceiling or walls.
- N. All empty conduit shall be equipped with a nylon pull rope continuous from outlet-to-outlet or end-to-end.
- O. Flexible conduit will be permitted for connecting lighting fixtures to junction boxes.
- P. Flexible connections in outdoor and damp locations shall be flexible liquid-tight metal conduit or non-corrosive seamless metallic tubing with watertight connections.
- Q. Install roof jacks for this construction in accordance with other sections of this Specification.
- R. The maximum allowed length of flex conduit at equipment connections is 18".
- S. Expansion joints for conduit shall be provided where required to compensate for thermal expansion and contraction.
- T. At all sub-panels and terminal cabinets, stub two 1"C and two 3/4"C into the accessible attic space. If the attic space is not accessible, stub conduits to a location

as directed by Architect or Engineer. Provide additional conduit stubs when indicated on the drawings.

- U. Support conduits on roof with prefabricated pipe supports (B-Line "Dura-Blok Series" or equal), spaced 8 ft. O.C. maximum. Minimum clearance from roof to framing channel shall be 4". Framing channel length shall be as required plus 50% spare length. Installation shall comply with manufacturer's recommendations.
- V. Any conduit entering underground pull boxes shall be sealed to prohibit water from entering the conduit. Conduits with conductors shall be sealed with a sealing compound after all conductors have been installed. All spare (empty) conduits shall be identified with either the "origination" or "destination" (example: to pull box 150' to the south, from Main Switchboard, etc.). The contractor shall use a scrap piece of $\frac{3}{4}$ " PVC conduit, approximately 5" in length and tie the nylon pull string thru it. Write the description on the conduit using an indelible/permanent marker.

3.2 OUTLETS

- A. In general, the locations of electrical outlets shall be as shown on the drawings; however, the Contractor shall make any changes necessary to suit conditions on the job or rearrangement of built-in fixtures and equipment as directed by the Architect or his representative.
- B. The Contractor shall study the general building plans with relation to spaces surrounding each outlet in order that his work may fit the work of others and that when fixtures or other equipment are installed, they will be symmetrically located according to room layout. Refer all conflicts and discrepancies promptly to the Architect.

3.3 OUTLET BOXES

- A. Outlets for concealed wiring shall be flush with the finished wall or ceiling surfaces. Pull boxes, junction boxes and all others to which no fixture or device is to be attached, shall be fitted with blank cover plates, and painted to match surroundings. In order to reduce noise transmission between rooms, outlet boxes shall not be installed back-to-back. Where outlets are side by side and faced into opposite rooms, the boxes shall be at least 6" apart, except in fire rated walls space boxes at least 24" apart. If the boxes are connected together, the connection shall be flexible and shall have openings packed with fiberglass.
- B. The Electrical Contractor shall inform himself of wall thickness throughout the building and shall provide outlet boxes of suitable depth that can be flush mounted and yet will be deep enough to contain the particular apparatus involved. The location of exposed pull or junction boxes will be subject to the Architect's approval.

- C. Outlets from which lights are suspended shall have approved 3/8" fixture studs fastened through from back of box. All outlet boxes and particularly those supporting fixtures shall be securely anchored in place in an approved manner. Support outlet boxes and fixtures in acoustic ceiling areas from building structures, not from acoustic ceilings. All lighting fixture outlets shall be coordinated with mechanical, architectural, or other equipment to eliminate conflicts and provide a workable, neat installation.
- D. Where more than one switch occurs at the same location, use multiple gang outlet boxes covered by a single plate; provide box partitions as required by the C.E.C. Switches controlling lights and/or outlets on emergency power shall be kept entirely independent of all other switches not on emergency power by mounting in a separate box.
- E. Outlet box extensions shall be UL listed and shall be attached to box with threaded metal screws. "Flash guards" are not permitted to be used as box extensions.

3.4 LOCATIONS OF OUTLETS

- A. The Architect reserves the right to make reasonable changes in the indicated locations before work is roughed in without additional charge to the Owner.
- B. Where wainscot occurs at the 4'-6" level, the switch shall be mounted lower in the wainscot as near the 4'-0" level as possible, but in no case, shall the switch be partially in the wainscot and partially in the wall. It shall be the Electrical Contractor's responsibility to verify all door swings. Switches, unless specifically noted, shall be on the strike side of the door. If switch is indicated on hinged side of door, verify location with Architect.

3.5 CONDUCTOR IDENTIFICATION AND INSTALLATION

- A. The drawings indicate the arrangement of outlets on each branch circuit and the circuit tags show the number of the circuit, and the board to which it will be connected.
- B. Circuits indicated with the same numbers shall be connected to the same breaker on the panelboard.
- C. All feeders and branch circuits shall be tagged in all pull boxes and in the gutters of all panels to which they connect.
- D. All wiring shall be done in identified neutrals.
- E. No wire shall be installed until all work of other contractors that might cause injury to the said wire has been completed. Care shall be used to pull wires to ensure that

no damage occurs to the insulation. A wire lubricant shall be used for pulling in wires.

- F. In making the connection of all branch circuits to the terminals of switches, base plugs, etc., the wires shall be looped around the binding screws or be fitted with connecting lugs. At the ceiling outlets, this Contractor shall leave not less than 6" of free ends on each wire for connections to the fixtures.
- G. No splices shall be permitted except in outlet boxes, and in panelboard gutters.
- H. Switches and receptacles shall be securely fastened to the outlet box. Where the outlet box covers are back of the finished walls the switch or receptacle shall be built out from the same with washers so that it is rigidly held in place to the box. The floating of any switch or receptacle will not be permitted.
- I. All signal and communications conductors shall be identified in terminal cabinets as to type of system e.g.: clock, bell, fire alarm, etc. and location of other end of conductor by room number or name as directed by Owner. Identification shall be by numbers at terminal strips and a numbered directory in cardholder inside terminal cabinet.
- J. Fire alarm system cabling and wiring shall be color-coded as follows:
 - 1. Initiating Devices: Addressable cable, red jacket.
 - 2. Signaling Devices: Black and Red wires for horns, strobes or horn strobes.
 - 3. Speaker cable, blue jacket for speakers.
- K. All power wiring size #6 AWG and smaller, shall be factory color-coded. For larger than #6, mark conductors on each end and at all junction and/or pull boxes with a 1" band of colored pressure-sensitive plastic tape. For isolated ground wires, mark with a 1" band of green tape, followed by a 1" band of yellow tape, followed by a 1" band of green tape. Colors for each phase and the neutral shall be consistent throughout the system. Color code shall be as follows:
- L. The white or gray conductor shall be the neutral at each outlet. All switches shall be installed in "hot" leg. On all lighting circuits the switch leg shall be purple from switch to fixture. All travelers from switch to switch on 3 and 4-way switches shall be pink. This color code shall be followed by Contractor for all fixture whips except for factory-manufactured whips. When factory manufactured whips are used, color code shall apply to all wiring except the factory whip.

- M. Conductors having white, gray or green covering shall not be used to indicate anything other than neutral or grounding. This limitation applies to all power, lighting, and control circuits.
- N. Installation of conductors shall be made in a neat and workmanlike manner to meet Code requirements and shall be run continuous without weld, splice or joint between boxes. Do not install wires in conduit unless the entire system of conduit and outlet boxes is permanently in place. All conductors shall be pulled using a UL approved wire lubricant.
- O. Make all terminations at motors using 3M Series 5300 Motor Lead/Cable Splicing Kits. Make connections per 3M written installation procedures.
- P. On all bolted electrical connections, the Contractor shall use Belleville washers.
- Q. All wiring to be neatly bundled and tied with nylon cord or plastic straps.
- R. When approved by the Electrical Engineer, splices in underground pull boxes shall be made with crimp on compression connectors and insulated with heat shrink sleeves or with splice kits listed by the manufacturer for wet locations. Wire nuts are not permitted. Cables and/or conductors for fire alarm and signals systems shall not be spliced.

3.6 GROUNDING

- A. The conduit system supports, cabinets, switchboards, etc., and neutral conductors must be permanently and effectively grounded, in accordance with Title 24 of the California Code of Regulations. The neutral shall only be grounded at the main service location unless specifically noted otherwise on the drawings or required by the California Electrical Code.
- B. This Contractor shall exercise every precaution to obtain good contacts at all panel boxes, pull boxes, etc.: where it is not possible to obtain good contacts, the conduits shall be bonded around the boxes with a #6 AWG gauge conductor with ground clamps.
- C. All equipment cases, motor frames, etc. shall be completely grounded to satisfy applicable code requirements.
- D. At each building, the interior hot and cold-water piping and the interior aboveground gas piping shall be bonded to the building service equipment per C.E.C. #250.104.
- E. Do not use underground gas piping as a grounding electrode.

- F. Pull a green equipment ground conductor in all power conduits, both metallic and non-metallic.
- G. Pull a separate isolated ground wire to isolated ground receptacles, insulated green with yellow stripe, in addition to the equipment ground conductor.
- H. Isolated ground conductor shall begin at the isolated ground bus in the panel in the building served and shall not be connected to any neutral conductor or any item not isolated from the system ground. All isolated ground circuits shall have a separate neutral conductor (not used for more than one circuit). The isolated ground conductor cannot extend upstream from the building served.
- I. Each disconnect switch shall have a ground connector (lay in wire type) which shall be used for grounding the disconnect enclosure. The ground wire shall continue and be connected to the enclosure of the equipment served.
- J. Where there is more than one building supplied from a common service, provide a grounding electrode at each building per C.E.C. #250.32.
- K. At each telephone backboard and/or data backboard, provide a power distribution block (one pole with two primary openings and six secondary openings) and mount at + 18" A.F.F. unless otherwise noted. Run $\frac{3}{4}$ " C - 1 #6 AWG to the ground bar of the nearest panel or the ground bus of the main switchboard. Power distribution block shall be Square D #LBA 163206 or equal.

3.7 MOUNTING HEIGHTS OF EQUIPMENT

- A. Unless otherwise specified elsewhere or shown on the plans, the following mounting shall apply:
 - 1. Panelboards: 6'-0" top of box
 - 2. Disconnect Switches: 4'-0" to center line
 - 3. Contactors: 4'-0" to center line

3.8 IDENTIFICATION OF SWITCHES AND APPARATUS

- A. All switchboard circuits, externally operated switches and apparatus used for the operation of or control of circuits, appliances, or equipment shall be properly identified with an engraved Bakelite nameplates, 1" x 3", black letters on white background. All such nameplates shall be of the self-adhesive type and attached onto the apparatus by screws or rivets. Card holders in any form are not acceptable.

3.9 EARTHQUAKE PROOFING OF LIGHT FIXTURES

- A. Fixtures weighing more than 50 pounds shall be supported independently of the outlet box.
- B. Pendant type fixtures shall be designed so that they may swing horizontally in any direction a minimum of 45 degrees from the vertical. Pendant shall have ball aligner at top, and swivel connection at fixture. If there is an obstruction within the 45 swing of the fixture the Contractor shall provide a State approved restraint to keep fixture from swinging into the obstruction.
- C. All fixtures mounted in or on suspended ceilings shall be fastened to the ceiling-framing members in accordance with C.E.C. #410.36(B). Recessed fixtures in t-bar ceilings shall be provided with integral t-bar clips, one near each corner to attach it to the t-bar ceiling frame.
- D. Recessed fixtures in T-bar ceilings shall be attached to the building structure above with #12 Ga. slack safety wire at two diagonal corners of each fixture (two wires per fixture).

3.10 FIRE RATED AREAS

- A. Where light fixtures, conduit, cabinets, or boxes penetrate fire rated ceilings, walls or floors provide a fire rated enclosure or fire stop. Rating of enclosure or fire stop shall match or exceed rating of area penetrated. Verify location of fire rated areas with architectural drawings and with General Contractor.
- B. Where outlet boxes are recessed on opposite sides of a fire rated wall, boxes shall be separated by a horizontal distance of at least 24 inches. Where the wall opening for a steel electrical outlet box exceeds 16 sq. inches in area, or an aggregate of more than 100 sq. inches for any 100 sq. feet of wall or partition area, fire stopping is required.
- C. Penetrations in walls, floors or ceilings requiring protected openings shall be fire-stopped.
- D. Fire-stopped shall be of an approved material, securely installed and be in conformance with the 2019 C.B.C., Section 714.3.1 and 714.3.2.
- E. All required fire-stopping and joint sealants as a result of the work in Divisions 26, 27 and 28 is the responsibility of each individual trade. Refer to Sections 07 8400 and 07 9210, respectively.

- A. Contractor shall be responsible for electrical hook up and connections to all electrical equipment whether furnished by this Contractor or others, including wiring, conduit, disconnects, circuit breakers etc., even if not shown on drawings. Verify all locations and requirements with equipment supplier before rough-in.
- B. When there are fire sprinklers, the Electrical Contractor shall connect bell, flow and tamper switches and other electrical devices as required by Sprinkler Contractor and local and state fire marshal. Verify requirements with General Contractor before bid.

3.12 INTERRUPTION OF SERVICE

- A. Interruption of service in existing buildings shall not be made at a time which will inconvenience the Owner. Before making any final connections to the existing buildings or doing any other work that will interrupt the service, the Contractor shall consult with the Owner and schedule the work at Owner's convenience even if it is necessary to make such connections after regular working hours.
- B. This Contractor shall do all rerouting and reconnecting of existing electrical facilities made necessary by this construction. Care shall be taken not to disrupt existing facilities. If any facilities are disrupted, this Contractor shall replace or repair them at his expense and to the satisfaction of the Architect.

3.13 CHANGES

- A. Electrical Contractor shall consider the number of outlets for electric equipment shown on plans as final, but the Architect reserves the right to shift same, within reason, to a location and position which will meet more completely final requirements.

3.14 GUARANTEE AND TESTS

- A. All electrical equipment testing, and related costs shall be included in the Contractor's bid.
- B. Contractor shall obtain approval from the Architect of proposed independent testing agencies before any testing is started.
- C. Equipment of all kinds installed by this Contractor shall be tested to determine whether it fulfills the requirements of these specifications. The Contractor shall furnish all labor necessary to adjust the operation of the apparatus and make the connections for the tests. After the tests have been completed, the Contractor shall restore all connections, apparatus, etc., to their original condition.

- D. Should any piece of apparatus or any material or work fail in any of these tests, it shall be immediately removed and be replaced with new material by this Contractor at his expense and the portion of the work replaced be again tested by the Contractor.
- E. All circuit breakers, 100 amps or more, shall be tested by an independent testing agency in accordance with NETA specifications and a report submitted to the Architect. Any circuit breaker that does not pass the test shall be replaced.
- F. The entire installation shall be free from short circuits and improper grounds. Panels and circuits shall be tested for grounds and shorts. Each individual circuit shall be tested at the panel with the equipment connected for proper operation. Ground tests shall meet the requirements of the California Electrical Code. Upon completion of the work, a final inspection by the Architect and other interested authorities shall be conducted. This Contractor shall guarantee to repair or replace at his expense any material or equipment that develops defects or is determined not to be in conformance with the plans and specifications, during a period of one year after work is accepted by the Owner.
- G. The grounding electrode system at the main electrical service equipment shall be tested by an independent testing agency in accordance with the three-point fall of potential method as specified in IEEE Standard 81-1983. Maximum ground resistance shall be 25 OHMS. A copy of the test report shall be submitted to the Architect and Engineer of record.
- H. All feeder cables #2 and larger shall be tested for insulation resistance. Test report must include number of cable per phase & type of cable insulation.
- I. Three copies of the test report shall be submitted to the Electrical Engineer prior to the final job walk.
- J. The independent testing agency performing the above-mentioned tests shall be NETA or NICET certified or approved by the electrical engineer.

3.15 GROUND FAULT SYSTEMS TEST PROCEDURE (TESTS REQUIRED FOR 480V MAIN DISCONNECT)

- A. Visual and Mechanical Inspection: VISUAL AND MECHANICAL INSPECTION:
 - 1. Inspect for physical damage and compliance with plans and specifications.
 - 2. Inspect neutral main bonding connection to assure:
 - a. Zero sequence sensing system is grounded.
 - b. Ground strap sensing systems are grounded through sensing device.

- c. Ground connection is made ahead of neutral disconnect link on zero sequence sensing system.
 - d. Grounded conductor (neutral) is solidly grounded.
- 3. Inspect control power transformer to ensure adequate capacity for system.
- 4. Monitor panels (if present) shall be manually operated for:
 - a. Trip test
 - b. No trip test
 - c. Non-automatic reset
- 5. Proper operation and test sequence shall be recorded.
- 6. Inspect zero sequence systems for symmetrical alignment of core balance transformers about all current carrying conductors.
- 7. Verify ground fault device circuit nameplate identification by device operation.
- 8. Set pickup and time delay settings in accordance with the project Electrical Engineer's provided settings.

3.16 ELECTRICAL TESTS

- A. Measure system neutral insulation resistance to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
- B. Determine the relay pickup current by primary injection at the sensor and operate the circuit-interrupting device.
- C. Test the relay timing by injecting one hundred fifty percent (150%) and three hundred percent (300%) of pickup current, or as specified by manufacturer.
- D. Test the system operation at fifty-seven percent (57%) rated voltage.
- E. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.

3.17 TEST PARAMETERS

- A. System neutral insulation shall be a minimum of one hundred (100) ohms.

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PROJECT NO. 7567
08/05/2026

- B. Relay pickup current shall be set to a value between 20% and 25% of the rating of the main circuit breaker. The setting shall be the in-service setting unless otherwise specified.
- C. Relay time delay shall be the closest possible calibrated setting to .1 seconds. This shall be the in-service setting unless otherwise specified.

3.18 DEMOLITION

- A. Remove and/or relocate electrical facilities as required to clear areas for new construction.

END OF SECTION