

**SECTION 16010 – ELECTRICAL REQUIREMENTS FOR PUMP STATIONS****PART 1 GENERAL****1.1 REFERENCES**

1. General: The work shall comply with the most recent standards or tentative standards as published at the date of the contract and as listed in this specification using the abbreviation shown.
2. National Fire Protection Association (NFPA):
  - 1) 70 National Electrical Code
  - 2) 101 Life Safety Code
3. National Electrical Manufacturers' Association (NEMA):
  - 1) 250-1979 Enclosure Description and Application

**1.2 SUBMITTALS**

1. General: The following shall be submitted. Materials and equipment will be approved based on the manufacturer's published data.
2. Detail Plans: Detail plans shall be submitted for approval and shall consist of a complete list of equipment and materials, including manufacturer's descriptive and technical data; catalog cuts; and any special installation instructions that may be required. Detail plans shall be submitted for all materials and equipment specified. Applicable schematic diagrams, equipment layout and anchorage shall be shown.
3. Test Reports: The label or listing of the Underwriters Laboratories, Inc. shall be submitted as evidence that the materials or equipment conform to the applicable standards of that agency.
4. Certificates of Compliance: For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable Federal Specification, or standard of the ASTM, NEMA or other commercial standard, is acceptable.

**1.3 QUALITY ASSURANCE**

1. Standard Products: Materials and equipment shall be the standard catalog products of a UL listed manufacturer regularly engaged in the manufacture of the products that have been in satisfactory use for at least 2 years. All materials and equipment shall be in accordance with the ACSA Approved Products List included in section D of these Construction Standards
2. U.L. Listing: Equipment shall be constructed in a UL 508 and UL 913 listed controls manufacturing facility as applicable. The manufacturer shall provide certification of both ratings with submittals. The equipment shall bear the appropriate UL serialized label indicating the equipment supplied shall be constructed in accordance with the practices and requirements of UL.
3. Alternate Manufacturers: Alternate equipment must be approved by the Authority's Engineer. Any alternate equipment shall be noted as "alternate" when submittals are sent in for review.
4. Wiring: All wiring shall be minimum 600 volt UL type MTW or AWM and have a current carrying capacity of not less than 125% of the full load current. The conductors shall be in complete conformity with the National Electric Code, state, local and NEMA electrical standards. For ease of service and

maintenance, all wiring shall be color coded. The wire color code shall be clearly indicated on all submittal and as-built drawings.

5. **Bundled Wire:** All control wiring shall be contained within wiring duct with covers as manufactured by Panduit or equal. Where dimensional constraints prevent the use of wiring duct, wires shall be bundled and tied not less than every three inches with nylon self locking cable ties as manufactured by Panduit or equal. Every other cable tie shall be fastened to the enclosure door or inner device panel with a cable tie mounting plate with pressure tape. Where wiring crosses hinged areas such as when trained from the inner device panel to the enclosure door, spiral wrap shall be used.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

1. **General:** Delivery, storage, and handling shall be the responsibility of the Contractor and at a minimum shall be conducted in accordance with the manufacturer's recommendations.

### **PART 2 PRODUCTS**

#### **2.1 ELECTRICAL IDENTIFICATION**

1. **Identification Nameplates:** Major items of electrical equipment shall be permanently marked with an engraved plate and shall show an identification name, to identify the equipment by type of function as indicated.

#### **2.2 LIGHTING**

1. **Interior Lighting:** Interior light fixtures shall be industrial fluorescent fixtures, 120 V, with two 40-Watt lamps each, Crouse-Hinds catalog number FVN4240TG or equal.
2. **Exterior Lighting:** When required by the Authority, exterior lighting shall consist of one unit mounted to the front of the building above the door. Lighting unit shall be a totally enclosed weatherproof unit with integral ballast for mounting on the building. Housing shall be dark bronze finished, one piece die-cast aluminum, fitted with a vandal resistant Lexan reflector. Lamp shall be 175 watt mercury vapor-type for 120 volt service with motion sensor. Units shall be similar to General Electric "WL 175 Wallighter Luminaire".

#### **2.3 PUMP STATION BUILDING**

1. **Building:** All electrical equipment shall be installed within an enclosed building. Building shall be of such a size so as to provide adequate working space around all equipment and in front of all panels, in accordance with NEC requirements. Building shall be of the precast type as manufactured by Clearflow, or approved equal.
2. **Doors:** Provide steel doors and frames of the dimensions as shown on the plans that comply with ANSI/SDI 100. Doors shall be 1 ¾ inches thick. Face shall be minimum 18 gauge cold-rolled steel sheets completely flushed and seamless comply with ASTM A 568. Doors shall be insulated. Frames shall be fabricated of minimum 16 gauge, cold-rolled furniture steel complying with and ASTM A 568. Supports and Anchors shall be fabricated of not less than 18 gauge galvanized sheet steel. Primer shall be rust-inhibitive enamel or paint as specified by ANSI A 224.1. Finish shall be manufacturer's standard baking epoxy or enamel paint.

#### **2.4 CONDUCTORS AND CABLES**

1. **General:** All conductors used in the wiring system shall be soft drawn copper wire, having a conductivity of not less than 98 percent of that of pure copper, with 600 volt rating, unless otherwise noted. Wire shall

be as manufactured by Capital, General Cable, Triangle or approved equal. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid metallic conduit.

2. Conductor Types: The conductor types shall be as follows, unless otherwise noted:

- 1) Service entrance shall be type THHN or XHHW, rated at 90 degrees C.
- 2) Feeders and branch circuits shall be type THW or THWN, rated at 75 degrees C.
- 3) Control circuits shall be type TFF, rated at 60 degrees C.

## 2.5 CONDUIT

1. Conduit: Rigid conduit shall be galvanized rigid steel conduit or Intermediate Metal Conduit (IMC) with a minimum size of 3/4 inch unless otherwise noted. Flexible metal conduit shall be Liquid-Tight type, approved for continuous grounding, and shall be used only where approved by NFPA 70 and local codes. Conduit, couplings, and connectors shall be products of a reputable manufacturer, as manufactured by Allied Tube and Conduit, Triangle Conduit and Cable, National Electric, or approved equal.

## 2.6 BOXES

1. Outlet Boxes: Outlet boxes shall be made of galvanized sheet steel unless otherwise noted or required by NFPA 70. Boxes shall be a minimum of 4 inches square, and shall be complete with the approved type of connectors and required accessories. Boxes shall be manufactured by Appleton, Raco, Steel City or approved equal. Outlet boxes for exposed work shall be handy boxes with handy box covers unless otherwise noted. Outlet boxes located on the exterior in damp or wet locations or as otherwise noted shall be threaded cast aluminum device boxes such as Crouse-Hinds Type "FS" or "FD".
2. Receptacle Boxes: Wall receptacles shall be mounted approximately 18 inches above the finished floor (AFF) unless otherwise noted. All receptacle boxes shall be equipped with grounding lead which shall be connected to grounding terminal for the device.
3. Switch Boxes: Wall switches shall be mounted approximately 54 inches AFF unless otherwise noted. Where two or more switches are located, the switches shall be mounted in a gang outlet box with gang cover. Switches with pilot lights, motor starting switches and other special switches that will not conveniently fit under gang wall plates may be individually mounted.
4. Lighting Fixture Boxes: Lighting fixture outlet boxes shall be furnished with the necessary accessories to install the fixture. The supports must be such as not to depend on the outlet box supporting the fixture. The supports for the lighting fixture shall be independent of the ceiling system.
5. Pull Boxes: Pull boxes shall be installed at all necessary points, whether indicated on the plans or not, to prevent injury to the insulation or other damage that might result from pulling resistance or other reasons necessary for proper installation. Minimum box dimensions shall not be less than NFPA 70 requirements and shall be increased if necessary for practical reasons or where required to fit a job condition. Where boxes are used in connection with closed conduit, plain covers attached to the box with a suitable number of counter-sunk flat head machine screws shall be used. Pull boxes shall be constructed of galvanized sheet steel, minimum 12 gage.

## 2.7 RECEPTACLES

1. Heavy Duty Receptacles: Receptacles located outside or in wet locations shall be heavy duty, duplex, NEMA 5-15R, 15 amperes, 125 volts, with spring door gasketed covers similar to Crouse Hinds WIRD-1.

2. **Interior Receptacles:** Receptacles shall be specification grade, UL listed, NEMA 5-15R, brown duplex, 15 ampere, 125 volts AC, similar to Leviton Model 5262.
3. **Generator Receptacle:** The service panel shall be furnished with a 100 ampere UL service rated manual transfer switch and generator receptacle compatible with the ACSA's generator. Service shall have a double throw disconnect and shall be by Crouse Hinds or approved equal.

## 2.8 FANS

1. **Exhaust Fans:** Fans shall be Venturi mounted exhaust fan, with 16 inch diameter propeller, 960 CFM, nominal speed 1550 rpm, 1/30 hp, 20 inch square panel, polyester finish, corrosion resistant, equipped with bird screen and rain guard. Fan shall be Dayton or equal, Grainger catalog number 4C007.
2. **Motorized Damper:** Frame shall be 19 inch square overall, for 17 inch square frame opening. Horizontal mount, for intake application, extruded aluminum dampers, 120 Volts, power ON to open, spring return to close. Motorized damper shall be installed where indicated on the plans, and shall operate when exhaust fan is powered. Damper shall be Dayton or equal, Grainger catalog number 4C560, and shall be equipped with bird screen.

## 2.9 HEATING UNITS

1. **Unit Heaters:** Unit heaters shall be horizontal fan electric unit heaters, propeller type, equipped with integral or wall-mounted thermostat. Unit heaters shall be of an appropriate size to heat the area.

## 2.10 DEVICES

1. **Selector and Push Button Switches:** Selector and push button switches shall be industrial oiltight units with double break silver contacts rated to carry 5 amperes at 120 volts AC, to make 30 amperes and to break 3 amperes. Engraved nameplates with appropriate markings shall be provided with each switch. Units shall be Hand-Off-Automatic similar to Square D, Class 9001.
2. **Relays:** Relays shall be plug-in relays with contacts rated 5 amperes at 120 volts AC and clear polycarbonate covers. Relays shall be similar to square D RS14, Class 8501 general purpose relays with screw terminal sockets mounted in a NEMA 4 enclosure.

## 2.11 FLOAT SWITCHES

1. **Float Switches:** Float switch shall be 5 1/2 inch diameter type 316 stainless steel device with a 4 ampere mercury-free switch at 250 volts AC. The float switch cable shall be type SO with three #14 AWG fine stranded copper conductors. The switch assembly shall be installed in the neck of the float switch and held in place by a dual circular crimp. The float switch shall have a minimum net positive buoyancy of two pounds. Switches and cables shall be suitably secured to a rod or pipe column in the wetwell which shall be located to prevent obstruction to the normal motion of the switches. Switches shall be readily adjustable. Switches shall be normally open, closed on rise in water levels and shall be in accordance with the ACSA Approved Products List included in Section D of these Construction Standards.

## 2.12 SCADA

1. **SCADA System:** SCADA system shall be in accordance with ACSA Approved Products List.

## 2.13 PUMP STATION PANEL

1. **Power Service:** The incoming power service shall be as specified. The service pole and metering shall be provided by the local electric power company. A UL rated double throw main disconnect switch shall be provided by the Contractor and installed by the local electric power company.

The panel shall be furnished with a lightning/surge arrestor connected to each line of the incoming side of the power input terminals. The arrestor shall protect the panel against damage due to lightning strikes or overvoltage on the incoming power line.

A phase loss/unbalance/reversal and undervoltage protection assembly with adjustable nominal voltage setting shall be provided with three extractor type line voltage fuses. This device shall cutout pumps if all phases drop below 90% or if one phase drops below 80% nominal voltage. This device shall have a 0.5 second dropout delay and adjustable restoration time delay of up to five minutes.

2. **Motor Control Equipment:** A thermal magnetic circuit breaker shall be supplied as branch circuit protection for each motor. The circuit breaker shall have a minimum ampere interrupting capacity of 14,000 symmetrical RMS amps. The circuit breakers shall be operable through the inner door of the enclosure and shall have a trip rating to allow full voltage starting and continuous operation of the motors.

A NEMA rated, full voltage, across the line magnetic motor starter with ambient compensated, quick trip class 10 overload sensing in each phase to provide overcurrent and running protection shall be provided for each motor. The overload trip setting shall be determined by replaceable heater elements. Overload relays with an adjustable trip or requiring replacement of the entire overload relay to change the trip settings shall not be acceptable. Inner door mounted overload reset pushbuttons shall be provided.

3. **Pump Control Panels:** The control panel shall come prewired for installation and be provided by the pump supplier for use with the pumps provided. The panel shall be enclosed in a NEMA rated, 14 gauge minimum galvanized steel enclosure with hinged deadfront inner door. The door shall have a stainless steel hinge and pin and shall be padlockable. Panel shall be NEMA 4 if water piping is enclosed within building, NEMA 7 if sewage wet well and piping is enclosed within building, and NEMA 12 if piping is enclosed within building. A 120 volt GFI duplex convenience receptacle rated at 20 amperes shall be provided in the panel and shall be protected by a separate 20 ampere single pole circuit breaker, and shall contain the following:

Circuit Breakers mounted to serve as service disconnects

Run Lights

Manual-Off-Automatic selector switchers with 1" green run light

Pump starters

Quick-Trip Bimetallic Overloads

Level Controls

Automatic Pump Sequencer

Elapsed Time Meter for each Pump (nonreset type, to 99,999.9 hours)

Alarm Light (100 W, min)

Duplex Grounded Electrical Outlet (120V) GFI

Inner door mounted Red Seal Failure Lights

Panel mounted seal leakage relay

Two (2) inner door mounted 120 VAC powered running time meter measuring hours and tenths of hours of operation up to 99999.9 hours shall be furnished each for "Pump #1" and "Pump #2".

4. **Pump Controller:** The operation of the sewage pumps shall be controlled by a duplex pump controller. The controller shall provide automatic alternation of the pumps. In the event of power failure, the controller shall be capable of gradually bringing the system back to correct operation point on emergency power without causing excessive pressure fluctuations in the system. The controller shall feature a silence

push-button for the audible and visual alarms. The controller shall feature a test function to allow the manual simulation of wetwell excursions to test pump alternation and alarm circuits.

5. Pump Alternator: The automatic pump alternating unit shall provide positive alternation of the two pumps. The alternator shall be similar to Square D Type CA2SKE or approved equal.
6. Alarm Light: A NEMA 4X high water alarm light shall be mounted on the front of the building. The alarm light assembly shall use a 100 watt bulb with a red globe. The light shall operate on 120 VAC power. An Uninterruptible Power Supply (UPS) shall be provided or the light assembly shall be D.C. with a battery back-up for power failures.
7. Alarm Horn: If required, provide and install a vibratone type horn mounted on the front of the building. The horn shall provide a minimum of 80db at 10 feet. A push button silencer shall be provided in accordance with these standards.

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

1. General: Equipment specified in this section shall be installed in accordance with the manufacturer's recommendations and must meet all applicable requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated herein or shown. The installations shall comply with all applicable laws and ordinances in effect at the building site, with applicable regulations of the National Electric Code and with regulations of the utility company furnishing power to the site. All systems shall be completely assembled, tested, adjusted, and demonstrated to be ready for operation prior to acceptance by the Authority.
2. Field Service: The manufacturer of controlled system shall provide the services of a factory trained service technician for a minimum of two eight-hour days of field service to inspect the installed equipment, supervise start-up of the equipment and train the OWNER's personnel in the proper maintenance and operation of the equipment.

#### **3.2 INSTALLATION OF CONDUCTORS AND CABLES**

1. Sizes: Branch-circuit conductors shall be not smaller than 12 AWG. Conductors for 120-volt branch circuits more than 100 feet long and conductors for 277-volt branch circuits more than 230 feet long, from panel to load center, shall be increased one size to prevent excessive voltage drop. Class 1 remote control and signal circuit conductors shall be not smaller than 14 AWG. Class 2 remote control and signal circuit conductors shall be not smaller than 16 AWG. Gages of all wiring shall be adequate to meet the requirements of NFPA 70.
2. Wiring Methods for Cable Systems: Cables shall be installed concealed behind ceiling or wall finish where practical. Cables shall be threaded through holes bored on the approximate centerline of wood members; notching of surfaces will not be permitted. Sleeves shall be provided through bond beams of masonry-block walls for threading cables through hollow spaces. Exposed cables shall be installed parallel or at right angles to walls or structural members. In rooms or areas not provided with ceiling or wall finish, cables and outlets shall be installed so that a room finish may be applied in the future without disturbing the cable or resetting the boxes. Exposed nonmetallic-sheathed cables less than 4 feet above floors shall be protected from mechanical injury by installation in conduit or tubing.
3. Aluminum Cables and Conductors: **Aluminum conductors shall only be permitted on service entrance.** Aluminum conductors shall have ampacity of not less than the copper conductors. Wire connectors of insulating material or solderless pressure connectors properly taped shall be utilized for all splices. Pressure connectors for aluminum conductors shall have tinned aluminum bodies. Aluminum contact

surfaces of conductors and connectors shall be cleaned and covered with antioxidant compound prior to making the connections.

### 3.3 INSTALLATION OF RACEWAYS

1. **Conduit Types:** Only metal conduits will be permitted when required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in damp, wet or corrosive locations, when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Except as otherwise specified, Intermediate Metal Conduit (IMC) may be used as an option for rigid steel conduit in areas as permitted by NFPA 70.
2. **Conduit Sizes:** Conduit shall be of ample size to permit the ready insertion and withdrawal of conductors without abrasion. Conduit sizes shown are based on the use of copper conductors with insulation types as described in Part 2 Products.
3. **Conduit Installation:** All joints shall be cut square, reamed smooth and drawn up tight. All bends shall be free of dents or flattening. Conduit throughout the project shall be securely supported to the building structure in a neat and workmanlike manner. Conduits shall be continuous from outlets to cabinets, panels, junction or pull boxes, and shall enter and be secured at all such enclosures so that each system shall be electrically continuous throughout. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise permitted by Authority.
4. **Exposed Raceways:** Exposed raceways or conduit shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.
5. **Changes in Direction of Runs:** Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-binding machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.
6. **Underground and Below Slab-on-Grade Conduit:** All electrical wiring below slab-on-grade shall be protected by a conduit system. No conduit system shall be installed horizontally within concrete slabs-on-grade. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field-wrapped with 0.010-inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.
7. **Conduit in Slabs:** Conduits shall be installed as close to the middle of concrete slabs as practical without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness, and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as necessary.
8. **Conduit Stub-ups:** Conduits stubbed up through concrete floors for connections to freestanding equipment shall be provided with a short elbow and an adjustable top or coupling threaded inside for plugs, set flush with the finished floor. Wiring shall be extended in rigid threaded conduit to the equipment, except that where required, flexible conduit may be used 6 inches above the floor. Screwdriver-operated threaded flush plugs shall be installed in conduits from which no equipment connections are made to suit the devices installed.
9. **Supports:** Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, or ceiling trapeze. C-clamps or beam clamps

shall have strap or rod-type retainers. Rigid plastic conduits (if permitted as a wiring method) shall be supported as indicated above, except that they will be supported at intervals as indicated by NFPA 70. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and or machine screws. Raceways or pipe straps shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4 inch in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Conduit shall not be supported using wire or nylon ties. Raceways shall be installed as a complete system and be independently supported from the structure. Supporting means will not be shared between electrical raceways and mechanical piping or ducts and shall not be fastened to hung ceiling supports. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Bushings shall be installed on the ends of all conduits and shall be of the insulating type where required by the NFPA 70. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered. A pull wire shall be inserted in each empty raceway in which wiring is to be installed by others if the raceway is more than 50 feet in length and contains more than the equivalent of two 90 degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No.14 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. At least 10 inches of slack shall be left at each end of the pull wire.

10. **Communication Raceways:** Communication raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirements that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90 degree bends or the equivalent. Additional pull or junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall be not less than ten times the nominal diameter.

### 3.4 BOXES AND SUPPORTS

1. **General:** Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, or mounting of devices or fixtures. Boxes for metallic raceways, 4 inches by 4 inches nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces, or when located in hazardous areas. Large size boxes shall be NEMA 4 or as shown. Boxes in other locations shall be sheet steel except that aluminum boxes may be used with aluminum conduit, and nonmetallic boxes may be used with nonmetallic sheathed or metallic-armored cable system, when permitted by NFPA 70. Junction boxes shall not be permitted in wet wells.
2. **Mounting:** In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal stud "C" brackets snapped on and tab-locked to metal wall studs, shall be used to secure boxes to the building structure. When "C" brackets are used, additional box support shall be provided on the side of the box opposite the brackets. The edge of boxes for electrical devices shall be flush with the finished surfaces in gypsum, plasterboard installation. Boxes for mounting lighting fixtures shall be not less than 4 inches square except smaller boxes may be installed as required by fixture configuration, as approved. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be flush with the top of a block to minimize cutting of blocks, and boxes shall be located horizontally to avoid cutting webs of block. Indicated elevations are approximate. Unless otherwise indicated, boxes for wall switches shall be mounted 54 inches above finished floors. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes

and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box. Penetration of more than 1 - 1/2 inches into reinforced-concrete beams or more than 3/4 inches into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3. **Boxes for Use with Raceway Systems**: Boxes for use with raceway systems shall be not less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Sheetmetal boxes for other than lighting fixtures shall be not less than 4 inches square except that 4 inches by 2 inches boxes may be used where only one raceway enters the outlet. Minimum size boxes for telephone outlets shall be not smaller than 4-1/2 inches square and 3-1/2 inches deep.
4. **Boxes for Use with Cable Systems**: Boxes for use with cable systems shall be not less than 3 inches x 2 inches sectional boxes, 2 inches deep.
5. **Pull Boxes**: Pull boxes of not less than the minimum size required by NFPA 70 shall be constructed of aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

### **3.5 DEVICE PLATES**

1. **General**: One-piece type device plates shall be installed for all outlets and fittings. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate.
2. **Mounting**: Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified.

### **3.6 GROUNDING**

1. **General**: Noncurrent-carrying metal parts of electrical equipment shall be effectively grounded by bonding to the ground bus provided in the service equipment or panelboard.
2. **Ground Wire**: A green ground wire shall be furnished regardless of the type of conduit.

END OF SECTION