

PART I – GENERAL

- This section is valid only when considered in total with all other Contract Documents. Cross references, where noted, are for convenience only. Their inclusion or omission from any particular section in no way limits the scope of particular sections or the intent of any Contract Documents.
- Furnish and install approved raceway systems for all electrical conductors, including conductors for telephone, signal, special systems, control and other systems required by applicable codes, rules, and regulations. Raceways shall be sized according to National Electric Code unless shown larger than required by the N.E.C. All raceways shall contain code sized copper bond wire.
- It shall be the responsibility of the Electrical Contractor to determine from the architectural and engineering drawings and by actual determination at the site, the exact location of each and every outlet. The outlet locations shall be modified from those shown on the plans to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modifications to center within specific spaces. These modifications shall be made without change in contract price. The Owner reserves the right to relocate lighting fixtures and power convenience outlets to a point within eight feet of that shown, without any change in contract price, providing the contractor is advised of the new location prior to installation of the conduit and boxes affected. The contractor shall check such conditions throughout the entire job and shall notify the Professional of Record of discrepancies that may occur before proceeding with the installation of the work. Wall boxes shall be set in advance of wall construction. They shall be blocked in place and secured. All wall boxes shall be set flush with the finished building construction and the contractor shall furnish and install extension sleeves as required to extend boxes to the finished surfaces of special furring or wall finishes.
- Other Sections of this Division are valid only when considered in conjunction with these General Provisions.

SUBMITTALS

- Unless otherwise noted, the contractor shall prepare all shop drawings, product literature, etc. only as required to properly coordinate and construct the project.
- Review of submittals by the Professional of Record is limited to specific shop drawings as called for in the Project Manual.
- Shop drawings for review by the Professional of Record are not required for this section.

PART II – PRODUCTS

CONDUIT, FITTINGS, AND BOXES

- **Conduit:** Conduit shall be manufactured by National, Triangle, LTV. All conduit shall be furnished by one manufacturer with the exception of non-metallic, PVC coated and flexible conduit, and shall be

Underwriter Laboratory listed and approved for the installation in which it is to be used.

- **Rigid Conduit:** Rigid steel, hot dipped, galvanized, or sherardized with baked enamel coating, zinc coated threads and protective caps.
- **Thinwall conduit:** Electro galvanized "Electrical metallic Tubing" of cold rolled steel, electrically welded. Baked clear plastic enamel coating.
- **Armored Cable:** Shall be of one manufacturer. It will have an adequate path for ground per N.E.C. Section 250-51.
- **Flexible Conduit:** National "Flexsteel", Allflex flexible steel conduit, formed of one continuous length of electro galvanized spirally wound steel strip.
- **Liquid-Tight Flexible Conduit:** Anaconda "Sealtite" liquid-tight flexible steel conduit, formed of one continuous length of electro galvanized spirally wound steel strip with neoprene jacket.
- **Non-Metallic Type 40 PVC Plastic Duct:** Carlon PV-Duit Plus, as manufactured per NEMA TC-2 and UL-651 Standards and UL listed for underground uses.
- **Intermediate Metal Conduit:** Conduit shall be hot-dipped galvanized intermediate metal conduit manufactured in accordance with UL #1242.

CONDUIT FITTINGS

- Conduit fittings manufactured by Thomas and Betts, Raco, O.R. Gedney, or Appleton. All fittings shall be by one manufacturer and shall be UL approved.
- **Rigid Conduit fittings:** Threaded type, galvanized steel, or malleable iron, water and concrete tight. All connectors at cabinets, boxes, outlets, gutters, panelboards, etc., shall be nylon insulated, metallic bushings with double locknuts.
- **Thinwall Conduit Fittings:** Compression type, galvanized steel, rain and concrete tight. All connectors shall be nylon insulated. Indentor or set screw type fittings will be allowed as per local code.
- **Flexible Conduit Fittings:** Squeeze or screw type, galvanized malleable iron or steel, with nylon insulated throats.
- **Liquid-tight Flexible conduit Fittings:** Galvanized steel or malleable iron liquid-tight with neoprene gaskets, "O" ring and retainer, nylon insulated throats.
- **Non-Metallic Type 40 PVC Duct:** Joints of the ducts assembled together with approved couplings to make a water tight joint. Furnish and install expansion fittings on all non-metallic duct per manufacturer's recommendations.
- **IMC Fittings:** All rigid fittings shall be UL approved compression IMC fittings.

- *PVC-Coated Rigid Fittings:* Roblroy Plasti-Bond 2 as required for all PVC-coated rigid conduit installation.
- *Condulets:* Crouse-Hinds, R & S, Appleton, Efcor, Gedney or Killark cast ferloy types with sheet steel covers. Provide neoprene gaskets for all locations.

CONDUIT SIZE AND TYPE

All raceways shall be GRC for entire installation, except as noted or shown. Rigid steel conduit, elbows, standard couplings shall be hot dipped galvanized rigid steel. If partitions or walls are solid concrete or are grouted solid with concrete or mortar, rigid steel conduit shall be used, also where subject to injury or damage: e.g., consider area up to 4 feet above floor level subject to injury. Verify these areas prior to installation.

Conduit size and type to be used for various applications are as follows (unless shown otherwise on Contract Drawings):

- *Rigid Conduit:* All conduit, regardless of size, installed under poured concrete floor slabs and in walls unless otherwise noted. Rigid conduit in earth shall be PVC coated rigid conduit, or concrete encased.
- *Thinwall Conduit:* Connections to suspended unit heaters, fans, ceiling and where exposed above 6'-0" in dry interior locations where not subject to mechanical stress. EMT larger than 2" diameter shall not be used.
- *Flexible Conduit:* Connections to suspended unit heaters, fans, and similar small equipment subject to vibration not exposed to rain or water drip. Connections from junction box to lighting fixtures in accessible ceilings. Connection from junction boxes to switch for narrow switches in hollow metal jamb posts (mullions).
- *Liquid-tight Flexible Conduit:* Final connections to all motor operated equipment. Provide stranded green ground wire except as otherwise permitted by Article 351-9 of the N.E.C.
- PVC bends up to 45 degrees per manufacturer's recommendation. All larger bends shall be rigid galvanized conduit, wrapped with plastic tape half lapped. Make transition to rigid conduit with approved fittings.
- Intermediate metal conduit: Installed in all corrosive locations, or in earth unless otherwise noted as permitted by N.E.C. 345.3b. All risers and elbows from all underground conduit installations and as shown on Contract Documents.

General Note: Unless excluded by city code and manufacturers recommendation or previously stated requirement, EMT conduit is acceptable for use above slab.

WIREWAYS

- Wireways and fittings with screw and/or hinged cover as shown shall be constructed of code gauge enameled sheet steel.

- Wireways and fittings installed on exterior and where subject to water or similar conditions shall be raintight type construction without knockouts, constructed from galvanized sheet steel.
- Approved manufacturers are Square-D Company, Alwalt or Gibbons.
- Outlet boxes and accessories used in the conduit systems as manufactured by Appleton, Racor, Steel City, or Bowers. All boxes shall be electro-galvanized or zinc plated steel.
- *Location:* Approximate location of outlets is shown on Plans, but each outlet location shall be checked before installation. Refer to electrical notes on Drawings and Specification Sections covering systems and equipment types of boxes required and mounting instructions. Coordinate installation of boxes and conduit stubs with equipment supplier and Professional of Record.

TYPE OF BOXES

- *Flush masonry wall outlets:* Masonry box 2-1/2", 3-1/2" deep, with concentric K.O.'s (single or multi-gauged as required).
- *Wood or Metal Stud Wall Outlets:* 4" square box - 1-1/2" or 2-1/8" deep with conduit K.O.'s (plastic rings) and required square extension rings and/or device corners.
- *Wood or Metal Stud Wall Outlets (Multi-Gang):* Same as masonry outlets with required supports (no single gang boxes allowed).
- *Outlets in Plastic or Gyp. board Ceiling:* 4" octagon box, 2-1/8" deep, with conduit K.O.'s and required extension rings and/or covers. Fixtures not provided with prewired junctions shall have 4" octagon boxes above accessible ceiling with flexible conduit connection to fixture box of wiring channel.
- Where surface wall outlet boxes are allowed, they shall be the following types:
 - 2 gang 4" square box 2-1/8" deep, multi-gang solid masonry box 2-1/2" deep.
 - All boxes shall have a 1/2" raised steel cover and approved mounting accessories.
- Where outlet boxes are mounted on conduit stubs on roof or at other areas as indicated, boxes shall be Type FS or FD malleable iron, cadmium finish.
- *Floor boxes and fittings:* Russel-Stoll, Fullman, Steel City and comparable to as follows: Power (LEW #632SE-DFB and with #DCF-1 carpet flange in carpeted areas), telephone and low voltage signal (LEW #532SE with 2" #538 brass kick ring and DF-1 carpet flange in carpeted areas). Use deep boxes for all floor boxes where feasible.
- *Outlets in concrete:* Concrete boxes - depth as required with conduit K.O.'s and mounting logs designed to mount on forms without rocking.

- *Outlets for W.P. receptacles:* Boxes shall be type FS or FD case steel.
- For exposed wiring on the exterior of building and on interior of building where subject to water, use cast ferrous type boxes with weatherproof covers, and neoprene gaskets. For other exposed wiring on the interior of building, use code gauge 4" square or larger galvanized boxes and 1/2" raised steel cover plate.

PULL BOXES AND JUNCTION BOXES AND WIREWAYS

- Install pull boxes, junction boxes, and auxiliary wiring gutters where indicated and where required to facilitate installation of the wiring. Such boxes and gutters shall meet all requirements of Articles 362, 370, and 374 of NEC.
- For concealed conduit, install flush with ceiling or wall with covers accessible and easily removable. Where flush boxes are installed in finish ceiling and walls, provide cover to match material and finish specified for devices (Paragraph 7.7) which shall exceed the box face dimensions by a sufficient amount to allow no gap between box and finished material.
- Pull and junction boxes not specifically described in other sections or on the drawings, shall be fabricated of code gauge galvanized steel with screw covers, brass hardware, and baked enamel finish, equal to Circle AW.
- Pull and junction boxes installed in poured concrete floors: Flush type cast iron with watertight gasketed covers, gray metallic finish. Where boxes are installed in floors with tile or carpet floor covering, covers shall be of the recessed type to accommodate the floor covering. Cast iron boxes as manufactured by Lew Electric Fittings Company.
- *Boxes:* Not to be located in finished, occupied rooms without prior approval of the Professional of Record.

WIRE AND CABLE

General:

- Materials listed in this section are products of Anaconda Wire, General Cable, Southwestern and General Electric. All wire required for this project shall be furnished by one manufacturer, unless otherwise noted or specifically approved. Submit for review, prior to placing orders, a complete schedule of wire, cable, and connectors to be installed.
- In no case shall a conductor of size less than No. 12 AWG be used for lighting, receptacle circuits, or any other power. Where home-run conductors are specifically indicated to be larger than #12 (i.e.; three #10-3/4" C.), it shall be understood that the increase in conductor size shall extend the entire length of the circuit. Conductors for bus voltage control shall be minimum #14 AWG.

- All wire and cable is to be new and unused, 98% conductivity copper only, manufactured within a six month period preceding the delivery to the job site. Submit UL label with date (for all wire coils). All branch circuit wire to be delivered to the job in unbroken cartons or spools.
- Wire and Cable: NEC grades insulated to 600 volts by ASTM Standards unless otherwise indicated.

WIRE AND CABLE TYPES

Type THHN or THWN shall be used for branch circuit conductors. Type XHHW or THWN (90° C) shall be used for panel and equipment feeders, and where exterior exposure of raceways is encountered. All wiring to motors, or equipment and cases subject to vibration, shall be stranded.

Type AF (150° C); Minimum size No. 14 stranded, use for filed tap-off connections to incandescent fixture sockets, and other high operating temperature equipment where operating temperature exceeds 90° C.

CONNECTORS

1. Splices for Conductors No. 10 and Smaller: Made with Ideal, Wing-nut insulated, solderless, screw-on connectors (size as recommended by manufacturer).
2. Connectors for Conductors No. 8 and Larger: Of compression of split bolt types T & B, OZ, Blackburn, or Burndy mechanical connector. Fill connector voids with electrical insulation putty and follow with 3M Scotch Tape #50, so insulation is equivalent to or greater than insulation of conductor.
3. Control wiring and all other stranded wiring to screw connections shall be provided with T & B "STA-KON" terminals, or as noted on control drawings.
4. Install approved expansion joint type fittings in raceway systems crossing building expansion joints and as recommended by raceway manufacturer where expansion is caused by temperature changes or similar type conditions. Expansion fittings to maintain approved raceway system (provide bonding jumpers as required.)

IDENTIFICATION AND TAGGING

Wire and Cable for feeders, sub-feeders, control and branch conductors shall be identified as follows:

- Switch legs for local wall switches to be a distinctive color such as purple.
- Colors: Assigned to each conductor as described and carried throughout all main and branch circuit distribution.
- Electrical system color codes, main and branch conductors identified as follows:

DESCRIPTION	120/208 VOLT	277/480 VOLT
A Phase	Black	Brown
B Phase	Red	Orange
C Phase	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green with Yellow Stripe

- *Conductor Insulation:* Colored in sizes up through No. 8: conductors No. 6 and larger: May have black insulation but phase color coded with 1/2" band or colored tape at all junction and terminations.
- All conductors shall be tagged in all pull boxes, wireways, terminations, splices, or connections of any type. Tags to be of fireproof material as manufactured by "Brady" or approved equal.
- Mark underground stubouts with concrete monuments (8" x 8" x 8") installed 1" below finish grade, over but not in contact with capped ends. Identify capped empty raceway with linen tags located inside of raceway ends. Pitch all conduits uniformly to manholes to eliminate pockets. All joints shall be watertight.
- Numbered bands to identify each wire or cable at panelboards and/or piece of equipment served, or connection point.

ACCESS PANELS

Provide access panels in building construction where required for access to concealed junction boxes, pull boxes, etc.

Access panels shall be of the flush steel panel type of ample size to permit inspection and servicing of the concealed item. Panels shall be verified with Section 08305 Metal Access Doors.

WIRING DEVICES

- All wiring devices shall be as manufactured by Hubbel, G.E., Woodhead, or Leviton unless otherwise noted or shown. Numbers shown are for Hubbell. All devices to be of one manufacturer.
- All devices heavy-duty specification grade.
- For additional devices refer to notes on drawings.
- Cover plates for each and every device including telephone outlets shall be furnished and installed under this contract. All plates shall be one piece. No sectional plates will be allowed. In all finished areas, furnish and install cover plates with matching screws. Confer with Professional of Record and provide color as required. In mechanical equipment room, and other similar areas with exposed conduit, furnish galvanized steel plates.

COVER PLATES (WHITE IN COLOR)

- Products specified herein shall be specification grade, as manufactured by Hubbell.
- Provide gang cover plates for grouped switches.
- Engraving device Plates: All device plates installed on devices other than 120-volt, 1-phase, 20A shall be engraved and filled with black filler stating the characteristics (i.e., voltage, phases, and capacity).

PART III – EXECUTION

CONDUIT INSTALLATION

- Conduit Systems: Installed for all wiring, lighting, power, signal, control communications, etc. Install conduit below or above concrete floors or roof.
- Minimum size conduit 3/4" trade size underground, or under slab, 1/2" trade size above grade for 12 AWG. or less only. Where specified size is not called for on drawings or in the specifications select size required from Chapter 9 of N.E.C. Where specified sizes required by drawings or specifications are larger than Code required, the larger size shall be installed. All conduits shall be furnished with 200 lb. nylon pull cord for pulling wire by electrical contractor or others, provide labels for all computer and register conduit.
- All conduit shall be concealed, except in crawl spaces, unfinished equipment and storage rooms, equipment bays, mechanical equipment rooms and free standing equipment or as shown on plans.
- Where exposed raceways are permitted by the Professional of Record in finished areas, paint as directed by Professional of Record and use approved escutcheons where entering or leaving finished areas.
- All conduit shall be routed parallel or perpendicular to building construction. No conduit shall be installed less than 6" from any piping installed by other trades. Exposed conduit fittings (conduit type) for all sharp corners, tees, etc.
- Conduit system shall be mechanically and electrically continuous from panel and to all cabinets, junction, or pull boxes. Conduit shall enter and be secured to all cabinets and boxes in such a manner that all parts of the system will have electrical continuity.

CONDUIT

- Securely fasten at intervals as follows: 8 foot spacing up through 1" with N.E.C. scheduled spacing for sizes over 1". Fasteners. Two-hole malleable straps, minerlac hangers, or split pipe hangers. Multiple runs of conduit shall be uniformly spaced and supported on unistrut channels independently from building structure. Standard anchorage by Phillips self-drilling anchors and bolts, or concrete inserts. Any form of strap iron or wire hangers will not be allowed. Do not support raceways from other crafts, pipe, pipe supports, ducts, or other related equipment. Wire or perforated strapping shall not be used for hanging conduit. Unistrut channel hangers shall be supported by 3/8" minimum "all-thread".

- Vertical runs of raceways shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the conduit and shall rest securely on the building structure without blocking. Clamps shall be placed below couplings.
- Non-Metallic Conduits: Conduit banks not under building slabs shall be encased in concrete 4" minimum all sides. Separation between conduits of 3 inches shall be maintained by installing high impact styrene spacers with horizontal and vertical locking at intervals of 10 feet.
- Underground Conduits: All risers and elbows from underground conduit installations shall be PVC-coated, galvanized rigid steel long radius elbows with steel up to connection above floor.
- Apply thoroughly, Permacel 412 Ribbon Dope Thread Sealant or comparable material to male threaded ends of metallic raceways installed, below grade, in concrete or mortar or in wet type locations. Running threads shall not be used.
- Ground Wire: A separate copper grounding conductor shall be provided for the entire length of all raceways.
- Conduit runs from outlet to outlet and from outlets and junction points shall contain not more than three 90° bends, and shall not exceed 150 feet in length. Accessible pull or junction boxes in conduit shall be installed when more than three bends are required. Each junction box shall be supported independent of the conduit.
- When installing conduit, all cuts shall be smooth and square with the run. Inside and outside burrs shall be removed. Conduit joints in concrete or in the earth shall be made watertight with compound seal.
- Unless otherwise indicated where conduit raceways enter or leave the top of a concrete slab, it shall be accomplished with an approved hot dipped galvanized rigid steel (heavy wall) coupling, installed flush to 1/4" below finish floor level. Extend conduit raceways from flush coupling as required to complete run.
- Raceways installed below grade shall be installed a minimum of 24" below finish grade, or a minimum of 3" from surface of raceway to bottom side of 4" thick or greater, concrete slabs poured on grade.
- Conduit raceways shall not be installed where they will be subject to injury or damage, e.g. sharp rocks, in bottom of trench or backfill. Provide approved materials for backfill and install without damaging the raceways.
- Install with select backfill and a 4" thick protective concrete cap under driveways, alleys, streets, or similar areas. Where metallic raceways are in contact with earth, backfill, ABC type fill or similar type surroundings, they shall be encased in concrete with 3" minimum coverage on all sides or wrapped with #50 Scotch-Wrap, or similar plastic covering half lapped, or approved equal.
- Concrete for encasement shall be 2,500 lb. test concrete of maximum 3/4" aggregate.
- Underground conduit runs or banks shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following: two (2) inches between telephone conduit, two (2) inches between conduits containing cable operating at not over 600 volts, six (6) inches between a telephone conduit and any power circuit in the same envelope. Spacing in separators shall not exceed five (5) feet and be close enough to prevent sagging of conduits and breaking of coupling and watertight seals.
- Raceways shall not be covered until approved by Professional of Record and/or PETSMART Representative.
- Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor a sleeve made of Schedule 40 galvanized pipe shall be provided. The space between the conduit and the sleeve shall be filled with a suitable plastic expandable compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. Detailed drawings of proposed installation shall be approved by Professional of Record.
- The open ends of conduit shall be capped to keep out debris.
- Raceways extending through roof and similar areas shall be flashed in an approved manner (extend flashing 6" above and 4" below roofing, and provide rain collar). Verify flashing requirements with Professional of Record and comply as directed. Coordinate and schedule installation for a proper and approved installation. Pitch pockets are specifically not acceptable.
- Pull a mandril and swab through all conduits before installing conductors. Cleaning conduits with compressed air alone is not acceptable.

CONDUCTOR INSTALLATION

- Where applicable, or as directed, cover all exposed taps, joints and splices with approved insulating material, equal to original insulation of conductor; e.g. for 600 volt or less use sufficient self vulcanizing Okonite or approved equal, electrical rubber tape covered with manson, or approved equal, electrical friction tape of highest quality, or approved equal.
- Make splices and taps only when required and as directed in approved location, such as junction boxes, wireways, etc.
- Wiring, including fish tapes, pull wires, etc., to be installed in raceways shall not be installed until raceway system is complete, clean, dry and free of all foreign materials.
- Conductors sizes #8 and larger or conductors serving motors and where subject to vibration shall be stranded. #8 and smaller sized stranded conductors that terminate to a screw or similar type connection shall be provided with approved crimping type terminals.
- Lubricant to facilitate the installation of wire through raceway systems shall be "Polywater P."

SECTION 16100: BASIC MATERIALS AND METHODS

- Armored cable is permitted in concealed areas and shall be installed per Article 333.

WALL BOX INSTALLATION

Wall boxes mounted flush in wall shall not be back-to-back. Boxes shall have conduit openings plugged with duct seal. Install boxes plumb and square with all face and with front of box or cover located within 1/8" of face of finish wall. Boxes in masonry set with the bottom of the box tight to the masonry unit. Handy boxes and sectional switch boxes are not allowed.

DEVICE INSTALLATION

- In masonry walls, switch heights shall be adjusted as required, so they are at nearest mortar joint but no higher than 48" A.F.F.

- Receptacles heights shall be adjusted as required so they are at nearest mortar joint but no lower than 18" A.F.F.
- Where walls have wainscot finish, switch height shall be adjusted as required, so switch is either all in wainscot or all in wall above wainscot.
- Where light switches are located adjacent to doors, they shall be installed on "knob" side of door, not less than 2" and no further than 6" from door jamb.
- Prior to roughing-in outlet boxes, verify from general construction drawings, door swings, type of wall finishes, and locations for counters and work benches.

END OF SECTION