

SECTION 16111
CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes specific requirements, products, and methods of execution relating to conduit and conduit fittings approved for use at ANC. Type, size and installation methods shall be as required by code and as specified in the following.

1.2 QUALITY ASSURANCE

- A. Conduit and conduit fittings shall be standard types and sizes as manufactured by a nationally recognized manufacturer of this type of materials and be in conformity with applicable standards and UL listings.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Conduit types specifically approved for use shall be of the following types only:
1. Galvanized rigid steel conduit – GRC.
 2. Intermediate metal conduit – IMC.
 3. Rigid copper-free aluminum conduit.
 4. Electrical metallic tubing – EMT.
 5. Polyvinyl chloride conduit - PVC: May be Schedule 40 or Schedule 80.
 6. Flexible steel conduit - FLEX or flex: In short lengths as specifically permitted.
 7. Liquid-tight flexible steel conduit - LT: In short lengths, indoors, as specifically permitted.
 8. Extreme temperature liquid-tight flexible steel conduit - AT: Shall have temperature rating of minus 67 degrees F. to plus 220 degrees F., Liqueflex "ATLA", or as approved.
 9. Plastic-Coated Conduit - PCC: Shall be hot-dip galvanized Schedule 40 rigid steel conduit, coated outside with a 40 mil jacket of PVC and inside with a urethane compound; PVC coating shall be U.L. Listed for corrosion protection on steel conduit with no disclaimers; RobRoy "Plasti-Bond Red", or as approved.
 10. Other products not specifically approved such as ENT, MC Cable, etc., are not allowed unless specifically approved by ANC or noted otherwise in the ANC Electrical Requirements.
 11. Manufactured wiring systems are not approved.

2.2 FITTINGS

- A. Fittings utilized with rigid steel, IMC, and aluminum shall be galvanized steel or iron or copper-free aluminum and shall be threaded. Conduit bushings shall be provided and shall be of the insulated types. Where grounding bushings are required, provide insulated grounding bushings with integral pressure type ground lugs, Thomas & Betts "Blackjack", or as approved.

- B. Couplings and connectors for EMT shall be made of steel or malleable iron. Die-cast products shall not be used. All connectors shall have insulated throats. Setscrew types are not allowable.
- C. Fittings for PVC 40 shall be polyvinyl chloride, installed using PVC solvent to form a watertight joint, except elbows (including bends exceeding 15 degrees) shall be metallic. These metallic elbows and bends shall be of the type specified in this section for the environment in which they are to be installed.
- D. Fittings for flexible metal conduit shall be steel or malleable iron only. All throats shall be insulated.
- E. Fittings for liquid-tight flexible conduit shall be steel or malleable iron, of a type incorporating a threaded grounding cone, nylon or plastic compression ring, and a tightening gland, providing a low resistance ground connection. All throats shall be insulated.
- F. Plastic-Coated Conduit shall be connected only with similarly coated threaded fittings (including conduit bodies) and couplings, with overlapping plastic joints.

PART 3 - EXECUTION

3.1 USES PERMITTED:

- A. Conduits shall be sized as required by the application or as required by the NEC, whichever is larger. Base sizes on using type XHHW for wire sizes #6 and smaller and type THHN/THWN wire for wire sizes #4 and larger. Unless otherwise specifically approved, conduits installed in the following locations shall be of the types specifically identified only:
 - 1. Encased in concrete - rigid steel, PVC-40 or IMC.
 - 2. Outdoors aboveground or damp locations - rigid steel, rigid aluminum, IMC or extreme temperature liquid-tight flexible steel conduit (where required).
 - 3. Dry indoor locations, concealed or exposed - rigid steel, rigid aluminum, EMT (where not subject to physical damage), flexible conduit (where required), or IMC.
 - 4. Indoor locations, exposed, where susceptible to physical damage – rigid steel or IMC. This includes baggage handling areas, baggage makeup areas and areas accessible to vehicles less than 96 inches above finished floor.
 - 5. Motor and equipment flexible connections - liquid-tight flexible conduit.
 - 6. Landside underground locations – PCC or PVC-40.
 - 7. Airside underground locations - PCC
 - 8. Service transformer secondary conduits (includes conduits between transformer and CT cabinet and between CT cabinet and MDP) – PCC.

3.2 INSTALLATION METHODS - GENERAL

- A. All conduit and tubing shall be cut square and reamed smooth at the ends and all joints made tight. Conduit threads shall be lubricated with an approved thread lubricant.
- B. Raceways shall be concealed, except in electrical and mechanical rooms, bag makeup areas, and as otherwise noted or specified. Exposed raceways shall be run parallel or perpendicular to building lines and bent symmetrically or made up with standard elbows or fittings. Concealed raceways shall be routed as directly as possible with a minimum of bends.

Concealed raceways above lay-in ceilings shall be installed a minimum of 12 inches above the ceiling grid.

- C. Raceway for power wiring shall not be installed in the floor slab beneath telecommunication distribution rooms or closets.
- D. Each conduit shall enter and be securely connected to a cabinet, junction box, pull box or outlet box by means of a locknut on the outside and a locknut/bushing on the inside, or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter. All connections shall be made wrench tight. All locknuts shall be the bonding type with sharp edges and shall be installed in a manner that will assure a locking installation. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into threaded connections. All runs of conduit shall be protected from the entrance of foreign material prior to the installation of conductors.
- E. Conduit or tubing deformed or crushed in any way shall not be installed. Conduit shall be bent only with approved bender (hydraulic or hickey). Bending machines shall be used to make field bends in conduit of 1-1/4 inch size and larger. Torches shall not be used in making conduit bends.
- F. Raceways shall be spaced at least 6 inches from parallel runs of heating system pipes, flues, other high temperature piping systems, and other heat sources. This basic spacing shall be increased if necessary to ensure that raceways experience no significant temperature rise from external sources. Raceways shall not be embedded in any spray-applied insulation, fireproofing, or other materials that would restrict heat dissipation.
- G. Pull wires shall be provided in all spare and unused conduits. (Nylon "jet-line" or equal.)
- H. All conduits stubbed up out of floor and terminating inside of an enclosure shall have insulating grounding bushings installed.
- I. Raceways penetrating vapor barriers or traversing from warm to cold areas shall be sealed on the inside with a non-hardening duct sealing compound to prevent the accumulation of moisture, and shall be taped airtight to the vapor barrier on the outside.
- J. Raceways shall be provided with expansion joints where necessary to allow for thermal expansion and contraction. Set initial opening of expansion joints per manufacturer's instructions, to suit the ambient temperature at the time of installation.
- K. Provide flexible conduit connection or approved fitting at all seismic joints to allow for displacement of conduit in all three axes. Connection shall allow for movement in accordance with design of seismic joint. Non-flexible raceways crossing expansion joints or other areas of possible structural movement shall make provision for 3-way movement at such points by means of O-Z/Gedney Type DX fittings, or accepted equal. Such fittings shall be installed so that they are initially in the center of all 3 axes of movement (i.e., not deflected to make part of a conduit bend, or compressed or extended to compensate for incorrect conduit length).
- L. Flexible metal conduit with supplemental ground jumper shall be used for connection to vibrating equipment, or where installation conditions warrant its use. Liquid-tight flexible conduit with supplemental ground jumper shall be used for all motor and transformer connections. The ground jumper in flexible conduits shall be within the conduit.
- M. Length of flexible conduit shall not exceed 36 inches, except for lighting fixture whips and where specifically noted. Fixture whips shall not exceed 72 inches.

- N. Electrical raceways may penetrate roofing membranes only where absolutely necessary. Such penetrations shall be flashed and sealed as required for mechanical piping penetrations of roof.

3.3 INSTALLATION METHODS - TELECOMMUNICATIONS SYSTEMS

- A. Installation methods for telecommunication system conduits shall comply with Installation Methods - General, above, unless superseded by more stringent requirements of this section. Telecommunications conduits shall comply with the requirements of ANSI/EIA/TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces and the Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual. Note that some of these requirements are more stringent than the requirements of the National Electrical Code.
- B. There shall be no more than two 90-degree bends between pull points in telecommunications conduit. Pull boxes added to conduit runs as a result of this requirement shall be in accordance with Section 16132 - Pull and Junction Boxes. If it is not practical to install a pull box in the run due to field conditions the conduit size shall be increased to the next trade size for each additional 90-degree bend. Offsets shall be considered as equivalent to a 90-degree bend.
- C. Inside radius of conduit bends shall be at least 6 times the internal diameter of the conduit for sizes up to 2 inch trade size; 10 times the internal diameter of the conduit for sizes larger than 2 inch trade size. Where bending machine shoes are not available with the required bending radius for a one-shot field bend, factory bent, large radius 90-degree elbows shall be provided. Conduits of all sizes for use as optical fiber raceways shall have a minimum inside bend radius of 10 times the internal diameter of the conduit.
- D. Conduits shall be terminated and supported at cable trays in accordance with Section 16115 – Cable Tray.
- E. Use of flexible conduit for telecommunications shall be kept to a minimum and shall be at the discretion of ANC. Obtain prior written approval for the use of flexible conduit. Where required due to physical considerations, flexible metal conduit may be allowed in lengths not exceeding 4 feet. If used, flexible metal conduit shall be increased by one trade size for the application used (see Conduit Sizes).
- F. Conduits entering the telecommunications closet or equipment room through the floor shall be terminated 4 inches above finished floor. Conduits entering the telecommunications closet or equipment room from above shall be terminated 4 inches below the finished ceiling, but in no case shall the conduits terminate more than 12 inches above the ladder racking or distribution frame.
- G. Conduit sleeves connecting vertically “stacked” telecommunications equipment rooms and closets shall be terminated 4 inches above finished floor. Conduits and cutout openings between floors shall be sealed with firestopping material that is removable and reusable, to accommodate ads, moves and changes in the cabling system.
- H. Layout of conduits shall give consideration to nearby sources of electromagnetic energy such as electrical power wiring, large electric motors and generators, induction heaters, arc welders, variable frequency drives, etc. Maintain the greatest separation practicable between telecommunication raceways and sources of electromagnetic interference (EMI). A minimum of 5 inches of separation shall be maintained between telecommunication raceways and fluorescent lighting ballasts.
- I. Pull wires shall be provided in all spare and unused conduits. (Nylon "jet-line" or equal.)

J. Maintain minimum separation from $\leq 480V$ power wiring in accordance with the following table:

Condition	Minimum Separation Distance		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to open non-metal telecommunications pathways	5 inches	12 inches	24 inches
Unshielded power lines or electrical equipment in proximity to a grounded metal telecommunications conduit pathway	2.5 inches	6 inches	12 inches
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal telecommunications conduit pathway	--	3 inches	6 inches

3.4 CONDUIT SIZES - GENERAL

- A. Minimum sizes for rigid steel, IMC, PCC, rigid aluminum and PVC-40 conduits shall be 3/4 inch.
- B. Minimum size for EMT and flexible conduits shall be 1/2 inch, except fixture whips may be 3/8 inch as allowed by the NEC.
- C. Maximum size for EMT shall be 3 inch, except telecom backbone conduits may be 4 inch where specifically approved by ANC.

3.5 CONDUIT SIZES - TELECOMMUNICATIONS SYSTEMS

- A. Minimum size for conduit runs to outlets is 1 inch (based on six cables of 0.24 inch diameter). Conduit runs for other than six cables of 0.24 inch diameter shall be sized in accordance with the following Table:

CONDUIT TRADE SIZE	NUMBER OF WIRES OR CABLES (CABLE DIMENSIONS IN INCHES)									
	0.13" O.D.	0.18" O.D.	0.22" O.D.	0.24" O.D.	0.29" O.D.	0.31" O.D.	0.37" O.D.	0.53" O.D.	0.62" O.D.	0.70" O.D.
1	8	8	7	6	3	3	2	1	0	0
1 1/4	16	14	12	10	6	4	3	1	1	1
1 1/2	20	18	16	15	7	6	4	2	1	1
2	30	26	22	20	14	12	7	4	3	2
2 1/2	45	40	36	30	17	14	12	6	3	3
3	70	60	50	40	20	20	17	7	6	6
3 1/2	--	--	--	--	--	--	22	12	7	6
4	--	--	--	--	--	--	30	14	12	7

- B. Unless specifically approved by ANC, individual conduit homeruns shall serve no more than one telecommunications outlet. Conduits which serve more than one outlet (where specifically approved by ANC) shall be sized in accordance with the Table above to accommodate the total number of cables for all outlets served, based on a minimum of six cables per outlet.

3.6 STRUCTURAL COORDINATION

- A. Layout conduits in slabs to avoid compromising structural integrity. The maximum conduit size in concrete slabs not on grade (steel decks with concrete slabs) shall be 1 inch. Where conduits cross over one another, one of the conduits shall be routed in bottom of the deck flutes to maximize concrete cover. Where raceways are required or permitted to be embedded in concrete, the minimum concrete cover shall not be less than 2 inches.
- B. Underfloor raceways for slab-on-grade construction shall be embedded in the fill under the slab, not in the slab itself.
- C. Structural members shall not be cut, drilled, or notched for raceways or other electrical features unless specifically approved by ANC.

3.7 CORROSION-RESISTANT CONDUIT SYSTEMS

- A. In outdoor, damp, or corrosive areas, LT Flex shall be made up with the plastic-coated conduit manufacturer's matching coated fittings and supports. Straps shall be malleable one-hole type wherever feasible.
- B. PVC Conduit supports shall be the manufacturer's standard non-metallic items, arranged so as not to hinder lengthwise movement between expansion joints.
- C. Plastic-Coated Conduit supports shall be the manufacturer's matching coated items. Straps shall be malleable one-hole type wherever feasible.
- D. Any damage to plastic coatings shall be thoroughly and neatly repaired with the plastic-coated conduit manufacturer's standard touch-up compounds.
- E. In outdoor, damp, or corrosive locations, plastic-coated conduit shall enter enclosures by means of the manufacturer's matching plastic-coated weather-tight threaded hubs, and liquid-tight flex shall enter enclosures by means of matching plastic-coated connectors. The plastic jackets of both types of conduit entry fittings shall be sealed to the exterior of the enclosure with the conduit manufacturer's standard touch-up compound. At non-metallic boxes, each entry shall have a bronze bond bushing and NEC-sized copper-bonding jumper inside the enclosure.

END OF SECTION