16112 RACEWAYS AND CONDUIT

SPECIFIER:

CSI MasterFormat 2004 number: 26 05 33

An optional keynote to the Drawings follows major product titles, for A/Es using National CAD

PART 1 GENERAL

1.1 SUMMARY

- A. Provide all labor, materials, equipment and services necessary to complete the conduits, fittings and support work, as indicated on the drawings, and as specified herein.
- B. All materials provided under this section shall be listed by an OSHA-approved, Nationally Recognized Testing Laboratory (NRTL).

1.2 RELATED SECTIONS:

- 1. 01150 Mechanical and Electrical Coordination
- 2. 02221 Excavating, Backfilling, and Compaction for Utilities.
- 3. 02200 Earthwork
- 4. 07840 Firestopping and Smoke Sealing.
- 5. 07900 Joint Sealers.
- 6. 09200 Metal Studs, Metal Lath, Suspensions Ceilings, Plaster, and Stucco.
- 7. 09900 Painting.
- 8. 10400 Identifying Devices.
- 9. 16120 Wire and Cable.
- 10. 16131 Outlet, Pull, and Junction Boxes.
- 11. 16450 Grounding.

1.3 SUBMITTALS

A. Submit product data depicting manufacturer's literature, including printed installation instructions, and recommendations before starting work. Submit samples if requested.

B. Shop Drawings:

- 1. Provide layout for all floor plans with elevations depicting the entire cable tray system throughout the structure.
- 2. Designate components and accessories for cable trays including, clamps, brackets, hanger rods, splice plates connectors, expansion joints assemblies, straight lengths, fittings, and grounding.
- 3. Show accurately-scaled components and spatial relationships to adjacent equipment. Show cable tray types, dimensions, and finishes.
- 4. Submit shop drawings and product data under provisions of Section 01330 Shop Drawings and Product Data and samples.
- C. Provide certified copies of factory test reports performed according to NEMA Standard VE 1 on cable trays of types and size specified for this project.

1.4 QUALITY ASSURANCE

- A. All cable trays and components shall comply with NEMA Standard VE 1, "Cable Tray Systems".
- B. Electrical Component Standard: Components and installation shall comply with NFPA 70 National Electrical Code latest edition (NEC).
- C. All Cable tray components shall be the products of a single manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cable Tray Manufacturers:
 - 1. B-Line Systems, Inc.
 - 2. The George-Ingraham Corp.
 - 3. GS Metals Corp.
 - 4. Square D Co.
- B. Fibrated Emulsion Conduit Coatings:
 - 1. Karnak Chemical Corp., 220 Fibrated Emulsion.
 - 2. Monsey Products Co., Monsey Asphalt Emulsion Roof Coating Fiber.
 - 3. Sonneborn Building Products, Hydrocide 700B.

2.2 EQUIPMENT

- A. Conduit shall be sized according to NEC, unless otherwise noted. Feeders and home runs shall not be less than 3/4" diameter.
- B. Rigid Conduit:
 - Galvanized Rigid Steel Conduit (GRS): Hot dip galvanized or electro-galvanized, with corrosion resistant coating on the inside, threaded, standard weight steel conduit complying with Federal Specifications WW-C-581, ANSI-C80.1, UL-6 and Article 344 of the NEC.
 - 2. Intermediate Metal Conduit (IMC): Hot dip galvanized or electro-galvanized, threaded, steel conduit complying with ANSI C80.6 and Article 342 of the NEC.
 - 3. Rigid Non-Metallic: Schedule 40, PVC plastic 90 degrees C. complying with ANSI/UL 651, and Article 352 of the NEC.
- C. Electrical Metallic Tubing (EMT):
 - 1. Galvanized steel tubing with smooth interior coat of lacquer enamel or zinc coat.
 - 2. Comply with Federal Specifications WW-C-563, ANSI-C80.3, UL 797 and Article 358 of the NEC.
- D. Flexible Metal Conduit:

- 1. Steel: Flexible galvanized steel conduit (Greenfield) complying with Federal Specification WW-C-566, ANSI C33.92, UL 360 and article 348 of the NEC.
- Liquid tight flexible metal conduit shall consist of a core of flexible galvanized sheet tubing over which is extruded an oil resistant and liquid-tight jacket of polyvinyl chloride (PVC), complying with Article 350 of the NEC.
- 3. Minimum size for flexible metal conduit shall be 1/2".

E. Conduit Fittings:

- 1. Rigid Steel Conduit and Intermediate Metal Conduit: Zinc or cadmium plated steel or galvanized malleable iron complying with ANSI listings. Fittings shall be threaded type. Bushings for Rigid Steel Conduit: 1-1/4 inch and larger, provide the threaded grounding insulated type. Insulating inserts: Thermo-setting plastic or fiber material which conforms to the flame test requirements of UL 514, molded or locked into the metallic body of the fitting. The grounding means may be either pressure type wire terminals or copper grounding lugs.
- 2. Rigid PVC conduit: 90 degrees C., PVC fittings UL listed. Fittings shall match conduit and complying with ANSI/UL listings.
- 3. EMT fittings: Zinc or cadmium plated steel or malleable iron of the compression type or steel multiple point locking (set screw) type. Couplings and connectors for EMT: Made of steel only, rain and concrete tight, and be gland, rolled steel set screw or compression type. Provide all connectors with insulated throats. Fittings larger than 2 inches: Concrete tight only. Fittings shall comply with ANSI listings.
- 4. Flexible metal conduit fittings: Steel or malleable iron only with insulated throat, complying with Fed. Spec.W-F-406B.
- Fittings for Liquid-Tight Flexible Conduit shall incorporate a threaded grounding cone, a steel or plastic compression ring and a gland for tightening and shall be made of steel only with insulated throats.
- 6. Bushings and connectors shall incorporate an insulating insert of at least 150 degrees C. rated plastic or 105 degrees C. rated nylon. Conduit bushings made entirely of nonmetallic material are not allowed. Grounding and bonding bushings shall have clamp type terminal for copper conductor.
- 7. Expansion Fittings and Sealing Fittings: Shall be listed by a NRTL, with ground continuity means. Expansion fittings shall be deflection and expansion type.
- 8. Conduit sleeves shall be galvanized steel, cast iron, plastic or ductile iron pipe when they are located in concrete walls, foundations or floors.
- 9. Die cast zinc alloy fittings are not allowed on any type of conduit.

F. Conduit Supports:

- Pipe Straps: Formed zinc coated steel or malleable iron one-hole pipe straps or conduit clamps sized for conduits or tubing. Individual and multiple pipe hangers and riser clamps including all parts and hardware: hot-dipped galvanized throughout. Provide all U-bolts, clamps, attachments and hardware for hanger assembly and conduits. Design each multiple hanger to support load equal to or greater than the sum of the weights of the conduits, wires and hangers itself, plus 200 pounds. Hangers and hardware: Federal Specification WW-H-171d. Manufacturers shall be Allied Tube, Triangle Conduit or Carlon products.
- 2. Fastenings: Zinc coated or cadmium plated steel screws, bolts, toggles, and expansion anchors as required. Nailin or nail-n anchors are not allowed.

- 3. Electrical steel channels shall be equivalent to Unistrut P-3000 Series. Provide trapeze, clamps, supports, concrete inserts, galvanized steel or plated steel with galvanized conduit clamps, and threaded 1/4" diameter minimum suspension rods.
- 4. For individual branch circuit EMT or flexible metal conduit concealed above accessible hung ceilings only, "caddy clips" spring steel conduit clamps.
- G. Conduit Coatings: Steel conduit buried directly in the earth shall receive a factory applied PVC coating or 2 coats of fibrated emulsion conduit coating. Comply with manufacturer's application recommendations.
- H. Surface Raceways: Use only where specifically indicated. NRTL listed and comply with Fed.Spec.W-C-582, and Articles 376 of the NEC.

1. Manufacturers:

- a. Walker, Division of Butler Manufacturing Co.
- b. Wiremold.
- 2. Pull Wires (Pull String): Galvanized steel or nylon rope of sufficient strength to pull in the maximum size conductors through trade size conduit. Minimum strength shall be 200 lbs
- 3. Non-metallic surface raceways are allowed in limited use on renovation projects, and only with prior approval from of M-DCPS Facilities Design and Standards.

I. Cable Trays:

- 1. Description: NEMA VE 1, Class 12A, ladder type center hung tray designated to support a minimum of 50 pounds per linear foot or as required for cable weight.
- 2. Material: Aluminum.
- 3. Inside Width: As indicated on drawings (14" wide minimum)
- 4. Inside Depth: Four inches (4") minimum.
- 5. Straight Section Rung Spacing: Six inches (6") on center.
- 6. Wiring from cable trays to equipment, devices, or outlets shall be in metallic conduit.
- 7. Conceal cable trays above fully-accessible ceilings. Cable trays in exposed locations or above inaccessible ceilings such as plaster, metal, or concealed-spline are not allowed.
- 8. Cable trays shall not obstruct access to light fixtures, access panels, damper controls, piping valves, etc.
- 9. Provide fire rated, insulated cable in cable trays located in supply or return air plenums.
- 10. Fire-rating shall be maintained when cable tray penetrates fire-rated assemblies.
- 11. Cable trays shall not be located over exterior covered walkways.
- 12. Cable tray systems shall be of indicated types, sizes, and NEMA classes and shall be complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adaptors, hold-down devices, grommets, and blind ends as required and indicated.
- 13. Cable tray products shall have rounded edges and smooth surfaces.
- 14. Cable Trays, Fittings, and Accessories: Aluminum alloy 6063-T6 for rails, rungs, and trays, 505Z for fabricated parts.
- 15. Minimum Fitting Radius: Twelve inches (12").
- 16. Sizes and Configurations:

- a. Use "ladder type" at trunks, sized as indicated on plans.
- b. Use channel type tray at branches, six inches (6") wide minimum and with bottom ventilated.
- 17. Supports and Connectors: Cable tray supports and connectors, including bonding jumpers shall be as recommended by cable tray manufacturer.
- 18. Fasteners for Supports: Fasteners to connect cable tray supports to the building structure shall be all steel springhead type toggle bolts.
- 19. Firestopping (Comply with requirements of Section 07840 Firestopping and Smoke Sealing):
 - Materials shall be listed by an OSHA approved NRTL, and shall be FM approved for fire ratings. Materials shall be consistent with penetrated barriers requirements.
 - Sleeves shall be Schedule 40, or welded, black steel pipe sleeves. Sizes as indicated.

20. Warning Signs:

- a. Lettering: 1-1/2" high, black on yellow background with message "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- b. Materials and Fastening: Comply with Section 10400 Identifying Devices.

J. Wireways and Auxiliary Gutters:

- 1. Hot dip galvanized code gauge sheet steel, complete with knockouts, enclosures, and removable covers unless indicated as hinged.
 - a. Manufacturers:
 - 1) Hoffman.
 - 2) Keystone.
 - 3) Square D.
- 2. Exterior locations shall have weather-tight gasketed covers, joints, and drip-proof rain shields. Paint after installation with exterior enamel paint.
- 3. Wireways and gutters shall comply with NEC requirements.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not proceed with the work of this Section until conditions detrimental to the proper and timely completion of the work have been corrected in an acceptable manner.

3.2 INSTALLATION

A. Provide where indicated and where required, ducts, conduits, tubing, wireways, and gutters to form a complete and integrally grounded raceway system. The system shall be installed according to NEC and local code requirements. Components of the system shall

be of sufficient size, strength, and capacity to allow for placements, pulling-in, or other installation of conductors, wires, cables, splices, taps, and terminations whether included in this Contract or for future use without strain or damage to those items being installed.

- B. Provide pull wires in empty raceways where no conductors are installed in this Contract. Allow 10 inches minimum slack at each end of pull wire and securely caulk in place. Provide marking tags showing opposite destination noting building and closet number at each end.
- C. The minimum size of rigid conduit, EMT, and flexible metallic conduit shall be according to NEC except as follows:
 - 1. Unless otherwise specified under "Products" or shown on the Drawings.
 - 2. Unless otherwise shown on the Drawings, telephone conduits shall be not less than one inch (1") trade size.
 - 3. Feeders and homeruns shall not be less than 3/4" diameter.
- D. Check sizes of raceways to determine the green equipment ground conductor specified, shown, or required can be installed in the same raceway with phase and neutral conductors according to the percentage of fill requirements of NEC. If necessary, increase the duct, conduit, tubing, or raceway sizes shown or specified to accommodate conductors without additional cost to M-DCPS.
- E. Raceway and Conduit Locations: Unless indicated otherwise, conduit types specified shall be used in the following locations. Any deviation from this schedule shall be submitted for approval with corresponding price adjustments before installation. Any conduit installed and not of the specified type shall be removed and replaced with the specified type at no additional cost to M-DCPS.
 - 1. Exterior Raceways:
 - a. Below Grade:
 - 1) Below Grade Direct Buried:
 - a) Galvanized rigid steel (GRS), painted or PVC jacketed.
 - b) PVC Schedule 40, as noted on plans.
 - 2) Below Grade Concrete Encased:
 - a) GRS.
 - b) PVC Schedule 40.
 - b. Exterior Exposed Wet Locations:
 - 1) GRS conduit.
 - 2) IMC conduit.
 - 3) PVC flexible conduit, PVC jacketed with liquid tight fittings.
 - 4) Gutters, wireways, and troughs of the gasketed, raintight type.
 - c. Exterior Exposed Damp Locations:

- 1) GRS or IMC conduit
- 2) PVC flexible conduit, PVC jacketed with liquid tight fittings.
- 3) EMT conduit with steel fittings minimum of 8 feet above finished floor.
- 4) Gutters, wireways and troughs of the gasketed type.

2. Interior Raceways:

- a. Under Slabs on Grade:
 - 1) GRS (painted or PVC coated).
 - 2) PVC Schedule 40, with 12 inches clear to bottom of slab.
- b. Embedded in Concrete Walls or Floor On or Below Grade:
 - 1) PVC or GRS with threaded or concrete tight steel fittings.
- c. Embedded in Concrete Walls or Floors Above Grade:
 - 1) PVC Schedule 40.
 - 2) GRS or IMC with threaded or concrete tight steel fittings.
 - 3) EMT with concrete tight steel fittings.
- d. Concealed in Masonry Walls:
 - 1) GRS or IMC with steel fittings.
 - 2) EMT with concrete tight fittings.
- e. Concealed in dry wall construction, or in suspended ceilings:
 - 1) EMT or flexible metal conduit with steel fittings.
- f. Interior Exposed:
 - 1) GRS or IMC at 8 feet or less above finish floor.
 - 2) EMT with steel fittings more than 8 feet above finish floor.
 - 3) Option: EMT installed below 8 feet from floor in electrical, mechanical, and telephone rooms.
- 3. Sealing fittings shall be installed at the following points and as otherwise indicated:
 - a. Where conduits enter or leave hazardous areas and enclosures for explosionproof lighting fixtures, switches, receptacles, etc., use sealing compounds according to NEC of a type approved for the conduits.
 - b. Where conduits pass from warm locations to cold locations, such as refrigerated spaces and air conditioned spaces, use to prevent passage of water vapor.
 - c. Where required by the NEC.
- 4. PVC conduit shall not be used indoors either exposed or concealed, except embedded in concrete or under slabs on grade.

- a. The depth of conduits under interior slabs shall be based on the minimum allowable bending radii of stub-ups and NEC requirements.
- Stub-ups on exterior and exterior walls shall be GRS, with transitions from PVC to GRS occurring below grade. Curves to stub-ups shall be GRS.
- c. PVC conduit elbows into in-ground handholes are acceptable.
- d. PVC Indoor Exception: Exposed in the Main Electrical Room for protection of the main electrical grounding conductor.

F. Raceway and Conduit Installation:

1. Conduit Routing:

- a. Route feeders, homeruns, and conduits as indicated on drawings, except for minor deviations as accepted by the A/E.
- Maintain a minimum separation of 12 inches between conduits containing emergency feeders and conduits containing normal feeders.
- c. The routing of conduits, as shown on the plans, is general and diagrammatical.
- d. Before installing any work, examine the working layouts of all other trades to determine exact locations and clearances.
- e. Where equipment is installed by other trades requiring connection as specified in this section, determine exact conduit entry locations from the approved shop drawings.
- f. Modifications to conduit runs shown on the electrical drawings, based on this section, shall be made without additional cost to M-DCPS, and shall be subject to A/E approval.
- g. In determining clearances, conduit shall not be run within 6 inches of any heated pipe or duct, or if unavoidable, the conduit must be kept at least 1 inch from the outer covering.
- h. Directional Boring:
 - The use of directional boring meeting NEC requirements is acceptable as a cost savings feature, per condition basis with prior written approval by MDCPS Facilities Design and Standards.
 - 2) Directional boring shall not be used in sandy and/or loose stone soil conditions.

2. Conduits In Finished Spaces:

- a. Conduits, fittings, outlet boxes, and pull boxes shall be concealed in ceilings, floor slabs, walls, or partitions of the buildings.
- b. Provide sufficient space at concealed conduits over conduit and coupling for the applications of finished floor, walls, and ceilings.
- c. Examine the Drawings, and if necessary, confer with the A/E to determine the type of construction containing the concealed conduits and the space available for such conduits.
- d. Unless otherwise shown on the Drawings, conduit may be run exposed on unfinished walls, on un-furred basement ceilings, in mechanical rooms and in penthouses, attics, and roof spaces.

3. Roof Conduit:

- a. Avoid running conduit on the roof wherever possible.
- b. If absolutely necessary, roof mounted conduit shall be GRS, a minimum of 16 inches above roof. Coordinate with roofing specifications for penetration and support requirements.
- 4. Conduits Penetrating Waterproof Membranes Under Floor Slabs on Grade:
 - a. Coordinate installation of conduits before installation of waterproof membrane.
 - b. Membrane to be sealed waterproof to conduits as specified in Section 07120 before pouring of slab over membrane.
 - c. Provide Schedule 40 galvanized steel pipe sleeves for conduits penetrating floor slabs as specified in the section of the Master Specifications applicable to the Project.
- 5. Conduits Penetrating Waterproof Membranes on Walls: Provide properly coordinated Schedule 40 galvanized steel pipe sleeves for conduits in concrete forms as specified in the section of the Master Specifications applicable to the Project. Membrane to be sealed waterproof to conduits as specified in the section of the Master Specifications applicable to the Project.

6. Conduit Embedded in Concrete:

- a. Conduit embedded in poured concrete shall be of the specified type, unless otherwise indicated.
- b. Metallic conduit buried in the ground shall be of the specified type and painted with a rust inhibitor.
- c. The outside diameter of any conduit buried in concrete shall not exceed one-third of the thickness of the structural slab, wall or beam in which it is placed. The conduit shall be located entirely within the middle third of the member whenever possible.
- d. Lateral spacing of conduits buried in concrete slabs shall be not less than three diameters except where drawings indicate the concrete slab has been specially designed to accommodate a closer spacing of conduits entering signal or electric closets, panelboards, etc., or the arrangement is accepted by the A/E.
- e. In general, conduits shall not be run through beams, except where clearly indicated on the drawings, specified, or where allowed by the A/E. Specifically note such conditions on shop drawings for A/E review.
- f. No vertical conduit passing through horizontal concrete beams shall interfere with reinforcing. Where accepted by the A/E, horizontal conduit may pass through beams, provided they are not closer than 6 inches clear and are confined to upper half of beam section.
- g. Properly support conduit to be embedded to maintain correct location and spacing during concreting operations. If necessary, provide suitable metal supports for this purpose.
- h. Where a concrete embedded conduit passes through an expansion or contraction joint in the structure, install the conduit at right angles to the joint, and provide an approved conduit expansion fitting at the joint installed according to the manufacturer's instructions. Paint the conduit with an approved bituminous compound for 1 foot on either side of the expansion joint.

- Conduits concealed in slabs on grade shall be installed over vapor barrier.
 Underground rigid conduit not encased in concrete shall receive the specified conduit coating.
- j. Factory applied plastic resin or epoxy coated metal conduit and fittings may be used, provided that coating holidays and abrasions to coating are repaired with compatible mastic.
- k. At any 1 point, not more than 2 lines of conduits shall intersect in any portion of slab.
 - In all such cases, any additional conduit shall be rerouted through other areas, or run under the slab and stubbed through the slab at the required locations.
 - 2) Conduits and pipes shall have a minimum cover of 1 inch of concrete.
 - 3) Do not install conduit in slabs 3 inches thick or less.
 - 4) Under no conditions shall aluminum conduit be buried in concrete slabs.
 - 5) Conduits installed in slabs and rising CMU walls shall be stubbed within webbing of block and shall be extended vertically concurrently with laying of block.

7. Conduit Bending, Cutting, and Placement:

- a. Conduit bends and offsets shall be avoided where possible.
- b. Required bends shall be made with standard benders designed for the purpose and with a minimum radius of 6 times the internal conduit diameter.
- c. Make conduit bends according to the NEC unless otherwise shown on the contract Drawings. Use of a pipe tee or vise for bending conduit is not allowed.
- d. Conduit crushed or deformed shall not be installed.
- e. Bends shall be free from dents or flattening. Bends more than 360 degrees are not allowed in conduit between any 2 terminations of pull boxes, as per NEC requirements.
- f. Make no bend in surface raceways. Use factory formed fittings for surface raceways.
- g. The ends of conduit shall be carefully reamed out free from burrs before installation and after threading.
 - 1) Cuts shall be made square.
 - 2) Coupling of conduit by means of running threads is not allowed.
 - 3) Where it is impossible to run the conduit and coupling sections together, an Erickson coupling or other accepted combination coupling shall be used.
 - 4) Joints shall be made up mechanically tight.
 - 5) Joints in conduits concealed in slab, floor fill, earth, etc., shall be made using approved silicone paint on threads.
- h. Prevent lodgement of plaster, dirt, or trash in raceways, boxes, fittings, and equipment during course of construction. Clogged raceways shall be entirely freed of obstructions or replaced.
- i. During installation of conduit, unfinished runs and terminations in pull boxes, cabinets, etc., shall be capped until conductors are installed.
- j. Plastic caps designed for this specific purpose shall be used to cover and align conduits before concrete pours and shall remain on conduit stub-ups until conduit is extended. Caps shall have self-aligning, interlocking male or female wings molded on each side. Duct or electrical tape and wire are unacceptable.

8. Conduit Connections:

- a. Conduit and EMT runs shall be mechanically and electrically continuous from service entrance to outlets. Unless otherwise specified, 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 bushing on the inside or by means of a liquid-tight, threaded, self-locking, cold-weld type wedge adapter. Where nominal circuit voltage exceeds 250 volts:
 - 1) In rigid conduit, an additional locknut shall be provided, 1 inside locknut and 1 outside locknut.
 - 2) In EMT or flexible metal conduit, the 1 locknut shall be made wrench-tight.
 - 3) Locknuts shall be the bonding type with sharp edges for digging into the metal wall of an enclosure and shall be installed to provide a locking installation.
 - 4) Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections.
 - 5) Conduit bushings for power and branch circuits in sizes larger than 1 inch shall be metal and for sizes 1 inch or smaller may be PVC. Conduit bushings for all low voltage conduit sizes may be PVC.
 - 6) Protect vertical runs of conduit or EMT terminating in the bottoms of wall boxes or cabinets, etc., from the entrance of foreign material before the installation of conductors.
- b. Plastic conduit joints shall be made by brushing a plastic solvent cement on the inside of the plastic coupling fitting and on the outside of the conduit ends. Slip together the conduit and fitting, until seated, with a slight twist to set the joint tightly, and the conduit then rotated one-half turn to distribute the cement evenly. Remove excess cement built-up on the surface of the conduit.
- c. The end of each conduit one inch and smaller shall be provided where it enters a junction box, outlet box, cabinet, etc., with the locknut and bushing. For conduits 1-1/4" and larger, use insulated bushings with ground stud. If insulated bushings are of the fully insulated type, use additional locknuts inside the junction box or cabinet before installing the bushing. Provide conduit entering main distribution switchboard feeder pull boxes with insulated bushing with ground stud regardless of size.
- d. Install the conduit system complete before any conductors are drawn in. Each run of conduit shall be blown through and swabbed after plaster is finished and dry, and before conductors are installed.
- e. Install conduit to drain any moisture, collecting in the conduit, to the nearest outlet or pull box, where possible.
- f. Where metallic conduit is exposed to different temperatures, seal the conduit to prevent condensation and passage of air from one area to the other.
- g. Light and power conduit shall run from a permanent and continuous ground return back to the service ground connection point. Conduits used on systems entirely isolated from the light and power distribution system shall be electrically continuous and grounded in an approved manner. Ground cable trays to the conduit system.
- 9. Conduit Penetrations and Supports:

- a. Sleeves, conduits, or other pipes passing through floor slabs, beams, or walls shall be located to not impair the strength of the structure.
- b. Conduits penetrating the walls or smoke partitions shall be fire stopped (sealed). Filling materials for openings in floors shall be fire-resistive, and finished to prevent passage of water, smoke and fumes. Filling material for openings in walls shall be fire-resistive where it occurs in fire walls, and shall be installed to prevent the passage of air, smoke or fumes. Where conduit and wiring pass through fire walls or floor slabs, the Contractor shall fill the opening with fireproof sealant, as specified in Section 07840.
- c. Roof penetrations shall be made using approved flashings and counter-flashings. Do not penetrate cant strips or expansion joint covers with conduits. Do not run conduits up through roof nearer than 12 inches from toe of cant strip. Where conduits penetrate exterior walls near flashings, penetration shall be at least 3 inches above the flashing reglet.
- d. Where conduits passing through the openings are exposed in finished rooms, the finishes of the filling materials shall match and be flush with the adjoining floor, ceiling, or wall finishes.
- e. Where unused sleeves or slots are provided for future installation of conduit, etc., they shall be suitably identified if not readily recognizable.
- f. EMT and conduits not embedded in concrete or masonry shall be securely and independently supported so that no strain will be transmitted to outlet box and pull box supports, etc. Supports shall be rigid enough to prevent distortion of conduits during wire pulling.
- g. Run conduits exposed in unfinished spaces, mechanical equipment spaces, where specifically indicated on the Drawings, or with the expressed permission of the A/E.
 - 1) Feeder conduits shall be run exposed or in hung ceilings, except as noted.
 - 2) Where exposed conduits are installed, they shall be run parallel to the building walls or partitions, using approved conduit fittings.
 - 3) Exposed conduits shall be securely supported with malleable iron pipe straps, angle iron pipe straps, angle iron or steel channel racks or other approved means as required for clearance of other piping or ductwork.
 - 4) Wood hangers and perforated sheet metal hanger straps are not allowed.
 - 5) Spacing of conduit supports shall not exceed 7 feet.
 - 6) Horizontal feeder conduit banks shall have their hangers fastened to the building structure by approved means.
 - 7) Hangers for banks consisting of 1 or 2 conduits may be fastened from inserts in the slab.
 - 8) Auxiliary steel for fastening shall be furnished and installed under this section.
- h. Support individual conduits not larger than 1-1/2" diameter by means of one-hole pipe straps or individual pipe hangers. Support individual horizontal conduits larger than 1-1/2" diameter by individual pipe hangers.
- Conduit located in hung ceilings shall be supported in approved manner similar to exposed conduits.
- j. Branch circuit conduits above suspended ceilings may be supported from the floor construction above or from the main ceiling support members, however, the finished installation shall not interfere with the removability of ceiling panels.

- Individual branch conduits above suspended ceilings with removable panels may be supported from the ceiling suspension wires provided the load imposed on any individual wire is not greater than 64 pounds, including the ceiling weight.
- k. Unsupported vertical drops over 10 feet from bus ducts or at motors shall be in rigid steel conduit. For vertical drops of less than 10 feet EMT may be used. Brace conduit to prevent swaying.
- I. Space conduits installed against concrete or masonry surfaces away from the surface by clamp backs or other approved means.
- m. In dry locations, spring steel fasteners, clips, or clamps specifically designed for supporting exposed single conduits may be used instead of pipe straps or pipe hangers.
 - 1) Hanger rods used with spring steel fasteners shall be not less than 1/4" diameter steel with corrosion resistant finish.
 - 2) Spring steel fasteners shall be specifically designed for supporting single conduits or EMT
 - 3) Type, size and spacing of spring steel fasteners with accessories shall by approved by the A/E and the Contractor.
 - 4) Submit applicable load and rating data for approval.
 - 5) Wire shall not be used for support.
 - 6) Nails are not allowed for the support of conduit.
- n. Where 2 or more horizontal conduits or EMT run parallel and at the same elevation, they shall be supported on multiple trapeze pipe hangers. Each conduit or EMT shall be secured to the horizontal hanger member by a U-bolt, one-hole strap, or other suitably designed and approved fastener.
- o. U-bolts, clamps, attachments, and other hardware necessary for hanger assembly, and for securing hanger rods and conduits shall be provided. Each multiple hanger shall be designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger, plus 200 pounds. Hardware shall be hot-dip galvanized after fabrication.

10. Fittings:

- a. Expansion Fittings: Each buried conduit in or rigidly secured to the building construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings shall be made of hot dip galvanized malleable iron and shall have a factory installed packing that will prevent the entrance of water, a pressure ring and a grounding ring.
- b. In addition to the grounding ring, a separate external copper bonding jumper secured by grounding straps on each end of the fitting shall be provided.
- c. Sealing Fittings: Sealing fittings for use with rigid steel conduits shall be of the threaded, zinc or cadmium coated, cast or malleable iron type. Fittings used to prevent passage of water vapor shall be of the continuous drain type.
- d. Sealing fittings shall be installed and sealed according to the manufacturer's recommendations at suitable, approved, accessible locations. In concealed work, each fitting shall have an access door or panel to allow access to the fitting.
- e. Set screw and compression steel fittings shall be made up mechanically tight according to manufacturer's recommendations.

11. Conduit Fastening: Fasten raceways as follows:

- a. To Wood: Wood screws, sheet metal screws, or screw type nails.
- b. To Hollow Masonry: Toggle bolts or expansion bolts as required. Holes not used to be filled.
- c. To Concrete or Solid Brick Masonry: By steel expansion bolts. Holes drilled to a depth of more than 1-1/2".
- d. To Steel Work: Machine screws, welded threaded studs, or spring-tension clamps. Raceways or pipe straps shall not be welded to steel structures.
- e. To Light Steel Construction Partitions: Sheet metal screws. Bar hangers may be attached with saddle ties of 16 gage double strand zinc-coated steel wire.
- f. Explosive charge setting devices are not allowed for any type of fastening on the project.
- g. Conduits, tubing, or raceways shall be continuous from outlet to outlet, cabinet, junction box, or pull box.
- h. Surface Wireways and Auxiliary Gutters: Fasten according to manufacturer's directions with fastenings appropriate for surface as specified.
- i. Cable Supports in Vertical Raceways: According to NEC Article 300-19.

12. Flexible Conduit:

- a. Flexible conduits shall be used for connections to motors and other electrical equipment when it is subject to movement, vibration, misalignment, cramped quarters, or where noise transmission is to be eliminated or reduced. Flexible conduit used to meet the above requirements shall be of the liquid-tight type when installed under any of the following conditions:
 - 1) Exterior locations.
 - 2) Moisture or humidity laden atmosphere where it is possible for condensation to accumulate.
 - 3) Corrosive atmospheres.
 - 4) Where water or spray due to wash-down operations is frequent or possible.
 - 5) Wherever there is a possibility of seepage, dripping, etc., of oil, grease, or water.
- b. Flexible conduit shall be used for short connections to control devices, recessed fixtures, and similar items with enough slack to avoid tension. Connection between structure and first point of attachment to vibrating equipment shall be flexible.

13. Surface Raceways:

- a. Surface metal raceways shall be used where noted on Drawings. Surface metal raceways shall be securely grounded to outlet boxes or to back-plates and fixtures by means of bolts, screws, or other approved means. Ends of raceways shall be provided with bushings at entrances to boxes or canopies. A separate green ground conductor shall be installed in the raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.
- b. Fasten surface raceways to surface in manner similar to methods specified.
- c. Each surface metal raceway outlet box with an attached lighting fixture shall be of sufficient diameter to provide a seat for the fixture canopy.

- d. Where a surface metal raceway is used to supply a fluorescent lighting fixture having central stem suspension with a backplate and a canopy, with or without extension ring, the backplate and canopy will serve as the outlet box and no separate outlet box need be provided.
- e. A surface metal raceway outlet box shall be provided, in addition to the backplate and canopy, at the feed-in location of each fluorescent lighting fixture having end stem suspension.
- f. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, a backplate slightly smaller than the fixture canopy shall be provided and no additional surface mounted outlet box need be installed.

14. Cable Trays:

- a. Install cable trays according to equipment manufacturer's written instructions.
- b. Remove burrs and sharp edges of cable trays.
- c. Support cable tray independently from the building structural components.
- d. Comply with manufacturer's recommendations for selection and installation of supports.
- e. Strength of each support including fastenings to the structure shall be adequate to carry present and future load multiplied by a safety factor of at least four or 200 lbs., whichever is greater.
- f. Support Locations: Locate supports according to the recommendations of Article 6.6 of NEMA Standard VE 1.
- g. Installation of supports shall be according to cable tray manufacturer's written instructions and the recommendations of Paragraph 6.5 of NEMA Standard VE 1.
- h. Fastening Supports: Unless otherwise indicated, fasten cable tray supports securely to the building structure as specified in Division 16 Section "Supporting Devices".
- Direction Changes: Make changes in direction of cable tray with standard cable tray fittings.
- j. Locate cable tray above piping except as required for tray accessibility and as otherwise indicated.
- k. Firestopping: Where cable trays penetrate fire and smoke barriers including walls, partitions, floors, and ceilings, install fire-stopping at penetrations after cables are installed.
- I. Sleeves for Future Cables: Install capped sleeves for future cables through firestopped cable tray penetrations of fire/smoke barriers.
- m. Working Space: Install cable trays with sufficient space to allow access for installing cables.
- n. Grounding: Electrically ground cable trays and ensure continuous electrical conductivity of cable tray system. Use tray as an equipment ground conductor for itself only, not for connected equipment.
- o. Warning Signs: After installation of cable trays is completed, install warning signs on or in proximity to cable trays where easily seen by occupants of space.
- 15. Empty Conduits: Where empty conduit or tubing is indicated for wiring to be installed in future by utility company or by separate contract, install conduit or tubing according to previous requirements for conduit and tubing with following additional requirements:

- a. No length of run shall exceed 75 feet for 1/2" size, 100 feet for 3/4" size, and 150 feet for 1 inch or larger sizes.
- b. Raceways shall not contain more than four 90 degree bends or equivalent.
- c. Install additional pull or junction boxes to comply with above limitations, whether or not indicated.
- d. Inside radii of bends in conduits of 1 inch or larger shall be not less than 10 times nominal diameter.
- e. Provide pull wire in empty raceways.
- 16. Painting: Paint exposed conduit to match the surrounding wall or ceiling it is mounted against according to Section 09900 Painting.

3.3 FIELD QUALITY CONTROL

A. Grounding: Test cable trays to ensure electrical continuity of bonding and grounding connections.

3.4 ADJUSTING AND CLEANING

A. Upon completion of installation of cable trays, inspect trays, fittings, and accessories, remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION