ELECTRICAL MATERIALS AND METHODS

Scope

Provide raceways for all wiring. All exposed and concealed wiring (including low voltage control, telecommunications, and power limited wiring) shall be installed in raceways.

Provide spare raceways for future use.

- From recessed lighting and receptacle panels, to the above ceiling spaces for future circuits.
- In parking structures for future CCTV cameras and entrance controls.
- In animal rooms, and at environmental rooms, for future environmental monitoring.
- Telecommunications conduits on laboratory benches for future data connections.
- Power and data conduits in wet laboratories for clusters of high-powered computers.

Related Sections

Design Guideline Sections:
260543 - Underground Services for Electrical Systems

U-M Standard Details:
260000 Series - Electrical Standard Details

Conduits

Specify 1/2 inch through 4 inch diameter electrical metallic tubing (EMT) for indoor concealed, and exposed installations, not encased in concrete.

Specify galvanized rigid steel conduit or intermediate metal conduit (IMC) for:

- Indoor installations over 4 inches in diameter.
- Indoor installations embedded in concrete.
- Indoor installations of primary power cables and fire pump supply cables. Also encase these conduits in 2 inches (minimum cover) of concrete where they are routed through the building. As an alternative, NEC Type MI cable may be used without raceways for fire pump supply cables, but only with special permission.
- Outdoor installations above ground.

Specify Schedule 40 PVC conduit for installations embedded in concrete, except as noted in Section 16110.

Specify standard wall, fiberglass reinforced epoxy, conduit for installations in parking structures, tunnels and on cooling towers.

Specify flexible metallic conduit for final connections to recessed lighting fixtures. As an alternative, manufactured wiring systems or Type MC cable may be used above accessible ceilings. Manufactured wiring systems or Type MC cable shall not be used above permanent ceilings or in walls.

Specify liquid tight flexible metallic conduit for final connections to transformers, motors and other equipment subject to vibration or removal for maintenance. Final connections to transformers in electrical rooms only may be non-liquid tight flexible metallic conduit.

Connections to recessed power receptacles, and light switches, in areas with accessible ceilings:

A. In new 'metal stud and gypsum board partitions (walls)', the final connections may be made with type MC cable. This MC cable, shall:

   1. Be run to a box immediately above the accessible ceiling, and the box size shall not exceed 4-11/16" square.
   2. Conduit shall be used for the entire run, from this junction box, to the power source, load (lights), etc.
   3. No more than three circuits may be run through any given junction box.
   4. Individual conductors making up the MC cable shall be stranded copper, with separate grounding conductor, and steel corrugated armor. Individual conductors shall be color coded as required in section 16120.
   5. The MC cable is terminated using UL listed hardware intended for the cable and boxes being used, (and rated for commercial and industrial environments).
   6. The MC cable shall be secured in the wall cavity as required by NEC
   7. The MC cable shall be as short as it is necessary to serve the need and meet the Code

B. In existing 'metal stud and gypsum board partitions (walls)', where the wall is not being otherwise opened up, the final connections to new devices may be made flexible conduit and standard (separate) conductors. This flexible conduit shall:

   1. Be increased in size as necessary to maintain the proper fill for the wiring to be installed.
   2. Shall be installed and secured as required by NEC.
   3. Shall be as short as it is necessary to serve the need and meet the NEC.

C. In all other wall types and conditions use standard conduit, of the type appropriate for the wall construction.

Connections to other recessed devices, (including communication outlet boxes, junction or pull boxes, etc) shall be with standard conduit of the type appropriate for the wall constructionCable Trays

Specify ladder-type cable trays for:

- Telecommunications cables in telecommunication rooms, in laboratories, and corridors with open or accessible ceilings, and under computer room raised floors.
- Avoid installing cable trays in air plenum spaces.
- Overhead primary cables within substation rooms.

- Provide rollouts or vertical drops for routing the cables into the substation's primary switches.

Avoid specifying center spline cable trays, except where obstructions or support restrictions make installation of ladder cable tray impractical.

Surface Raceways

Where conduits cannot be concealed, specify metallic or plastic surface raceways for indoor exposed installations in finished areas to feed surface mounted outlets.

Boxes

Specify sheet steel switch and outlet boxes for use with EMT, and cast or malleable iron boxes for use with galvanized rigid steel conduit and IMC.

Specify PVC boxes for use with PVC and fiberglass reinforced epoxy conduit.

Specify compatible boxes, from the same manufacturer and of the same product line, for use with surface raceway installations.

Products

Conduits

Electrical metallic tubing shall be thin wall steel tubing, electro-galvanized or hot dipped galvanized inside and outside. Fittings and bushings shall be galvanized steel setscrew type connectors. Conduits 2" and larger will have fittings and bushings with two screw connectors.

Galvanized rigid steel conduit and intermediate metal conduit shall be hot dipped galvanized inside and outside, in 10' lengths and threaded on both ends. Fittings and bushings shall be threaded, cast or malleable iron, and hot dipped galvanized inside and outside.

PVC conduit and fittings shall be Schedule 40 and UL Labeled for 90 degrees C cables. Fittings shall be Schedule 40, solvent type, and from the same manufacturer as the conduit.

Fiberglass reinforced epoxy (FRE type) conduit shall be standard wall thickness, iron pipe size, sunlight resistant, and gray or black color. Fittings shall typically be push-fit on straight sections and solvent type at fittings and boxes. Connections of FRE conduit to PVC boxes shall be made with solvent type threaded fittings. Fittings shall be from the same manufacturer as the conduit**.**

Flexible metallic conduit shall be galvanized steel or aluminum. Fittings shall be of steel with cadmium or galvanized finish. Fittings shall be machine screw clamp type, single or two-piece. Self-locking, twist-in type fittings are not acceptable.

Liquid tight flexible metallic conduit shall consist of a flexible, galvanized steel core, a continuous copper ground strip and a polyvinyl chloride jacket. Fittings shall be steel liquid tight grounding type and from the same manufacturer as the conduit.

Cable Trays

Ladder type cable trays shall be aluminum with a 4-inch (minimum) rail height, and 9 inch maximum rung spacing. Rungs shall provide a flat surface for cable support of at least 5/8". The tray with a 10' span shall be capable of sustaining a working load of 75pounds per lineal foot (50 pounds of cable per foot, plus a 250 pound person sitting at mid-span), with a load deflection of 1.0 inch maximum when tested in accordance with NEMA VE1-3.01. 'Fittings' shall be from the same manufacturer and product line as the tray, and shall also have a 9-inch maximum rung spacing, and a 12-inch minimum bend radius. The side rail (or equivalent) shall be continuous through the 'fittings'. Preferred, but not required, are pre-drilled mounting holes on the upper surface of the side rails - will facilitate conduit terminations at the tray

Center spline cable tray (when allowed) shall be aluminum with top mounted rungs, 3 inch (minimum) load depth, ¾" inch minimum (flat) rung width, and 9 inch maximum rung spacing. The tray with a 10' span shall be capable of sustaining a working load of 75 pounds per lineal foot (50 pounds of cable per foot, plus a 250 pound person sitting at mid-span), with a load deflection of 1.0 inch maximum when tested in accordance with NEMA VE1-3.01. Fittings shall be from the same manufacturer and product line as the tray, and shall have a ¾" inch minimum rung width, a 9 inch maximum rung spacing, and a 12 inch minimum bend radius.

Tray fasteners shall be galvanized or zinc plated steel; and shall be configured and installed so no sharp, or threaded surfaces, protrude in the 'cable space'.

Surface Raceways

Surface raceways shall consist of a base and cover of. 040-inch thick minimum zinc plated or galvanized steel, or PVC, sized for the number of conductors contained within. Complete the installation with all connectors, fittings, bushings, boxes, covers and mounting hardware from the same manufacturer. All materials for a given location shall be of same color; with the color specified being one of the manufacturer's standard finishes.

Provide barriers to separate conductors of different voltages, or services.

Surface raceways shall be sized so that the installed wiring does not exceed NEC specified fills, and the minimum bend radius of the installed wiring is not violated - even at outlet box locations. [The telecommunication wiring will be Category 5E (4 pair), Category 6 (4 pair cable) and/or fiber strands, all to be installed without violating their minimum bend radius.]

Owner Installed Telecommunication Wiring

When calculating raceway fills, for telecommunication raceways assume 3, 4-pair, cables to each telecommunication outlet. This is the standard currently being used by the University

Boxes

Fixture, switch, outlet, splice and wire pulling boxes shall be cast or formed from carbon steel sheets of commercial grade steel not less than 14 gauge. Boxes shall be of one-piece construction, zinc or cadmium plated. Boxes shall be tapped for installing covers and plates as required.

Steel pull and junction boxes shall be rated NEMA 1 indoors, or NEMA 3R minimum outdoors, fabricated from galvanized or painted code gauge cold rolled carbon steel sheets. Boxes shall be of welded construction with flat, removable covers. Box covers shall be fastened in place by machine screws or hinges and latches. Self-tapping or sheet metal screws are not acceptable.

PVC pull and junction boxes shall be rated NEMA 3R minimum, molded in one piece, with integral mounting feet and flat, gasketed, removable covers. Box covers shall be fastened in place by machine screws. Self-tapping or sheet metal screws are not acceptable.

Supports

Hangers and brackets shall be made of steel pipe, channel iron, angle iron or prefabricated steel channel, and shall be galvanized or painted.

Hangers shall be of sufficient strength, and spaced, such that their deflection at any point does not exceed 1/240 of the hanger span length after the supported equipment, conduits, cable tray and cables are installed.

Anchors for heavy and large loads, mounted to gypsum board, hollow tile, block, or similar surfaces, shall be toggle bolt type. Install metal backer plates as needed for concentrated, or extra heavy, loads to be mounted to gypsum board walls. For heavy or large loads mounted to solid surfaces, use metal expansion, or epoxy anchors. Use lead shield anchors, or plastic expansion anchors, for supporting smaller loads. Powder-driven anchors shall not be used.

Execution

Raceways

Minimum power and control conduit size shall be 1/2 inch. Minimum telecommunications conduit size shall be 1 inch.

All medium (primary) voltage raceways, and any other raceways above 4", shall be rigid.

FRE raceways and PVC boxes shall be used in parking structures, tunnels, cooling tower enclosures, and all other areas with high humidity and/or corrosive environments. Tunnels sections passing through building mechanical rooms (and other related areas) are not exempted from these requirements even if non-FRE conduits are currently present.

Conduits in finished areas shall be concealed wherever possible and practical. When conduits cannot be concealed in finished areas, surface raceways shall be used.

Concealed and exposed raceways shall be installed parallel to or at right angles to building lines. Surface raceways shall be installed as close to room corners or trim features as possible to make the surface raceways less obvious. Use the surface raceway to route the wiring to a junction box above the finished ceiling whenever possible.

In renovation areas, with existing gypsum board walls, flexible conduit may be used from the new outlet box in the wall, to a junction box mounted on the wall immediately above the accessible ceiling. Size flex raceway to maintain equivalent cross-sectional area.

Raceways and other electrical equipment shall be separated from steam pipes, hot water pipes, and other hot surfaces by a minimum of 4 inch horizontally or 12 inch vertically.

Raceways and other electrical equipment shall be separated from ductwork and pipes so that they do not come into contact with each other.

Low voltage signal circuits shall be separated, or shielded, from power circuits to prevent the induction of noise into the signal circuits.

Raceway fittings and bends shall have bend radii greater than the minimum bend radii of the cables enclosed.

Metal raceways, fittings, boxes and enclosures shall be mechanically joined together to form a continuous electrical conductor providing effective electrical grounding continuity. This requirement, does not, however, negate the Guideline requirement for separate grounding conductors for all power circuits (as defined in Guideline Section 16450)

Raceway expansion fittings shall be provided at the intervals specified by the manufacturer, and all building expansion joints.

Directional changes in primary conduits above ground shall be made with 3’ minimum radius sweeps and long radius elbows. Those underground shall be with 20' minimum radius bends.

Conduits entering panels located outdoors, in parking structures, in steam tunnels and on cooling towers shall enter from the sides, back, or bottom. Conduits shall not enter from the top.

Weep holes shall be drilled in the bottom of all switch and outlet boxes installed in parking structures and tunnels.

Mounting Heights

Equipment and devices shall be installed at the following heights:

- Receptacles (Wall): 18" A.F.F. to center
- Receptacles (Above Counter): 48" A.F.F. to center
- Receptacles (Unfinished Area): 48" A.F.F. to center
- Surface Raceway Receptacle Strips: 42" A.F.F. to bottom (unless noted otherwise)
- Light Switches: 48" A.F.F. to center
- Telephone Outlets (Wall Phone): 54" A.F.F. to center

- Telephone/Data Outlets: 18" A.F.F. to center
- Clock Outlets: 88" A.F.F. to center
- Fire Alarm Pull Stations: 48" A.F.F. to center
- Fire Alarm Horn/Strobes: 80" A.F.F. to bottom or 6” below ceiling (whichever is lower)
- Card Readers: 48" A.F.F. to card slot
- Security System Controls: 48” A.F.F. to center
- Thermostats/HVAC Controls: 48” A.F.F. to center
- Electrical Panels: 72" A.F.F. to top
- Safety Switches/Motor Starters: 72" A.F.F. to top (except top of handle shall not exceed 78" A.F.F.)
- Motor Control Switches/Pushbuttons: 60" A.F.F. to center

Supports

Electrical equipment and raceways shall be supported independently of supports provided by other trades.

Equipment (other than conduit) to be surface mounted to masonry or concrete walls shall first be secured to steel channels that in turn are mounted to the wall. Do not mount the equipment directly to masonry or concrete.

Equipment to be surface mounted on other wall surfaces may be directly mounted to the wall, unless the equipment's load exceeds the strength of the wall material. Where weight exceed wall capability, in finished areas, install steel backer plate in the wall. In unfinished areas install steel channels as noted above to spread the load.

Floor mounted equipment shall be secured to 4 inch thick concrete housekeeping pads. Pads to be sized 4 to 6 inches longer, than equipments length and width. Bevel edge of pads, and reinforce as appropriate.

Conduits and boxes shall be supported using steel conduit straps or 1/4-inch minimum diameter threaded rod hangers. Conduits shall be supported at intervals not exceeding 10 feet. Suspended ceiling hangers or hanger wire shall not be used (except to support manufactured wiring system cables and Type MC cables).

Cable trays shall be supported with support brackets or 3/8-inch diameter minimum threaded rod hangers at intervals not exceeding 8 feet for straight runs. Additional supports shall be provided at tray fittings.

Flexible metallic conduit to motors and similar equipment shall not exceed 3 feet in length, and shall have adequate slack to absorb the maximum vibration.

Flexible metallic conduit to lighting fixtures shall not exceed 6 feet in length. Place box and flex conduit so the light fixture can be lifted out of accessible ceilings when required, and/or long enough to place fixture in adjacent 'tile' location

Flexible metallic conduits, and manufactured wiring system cables, shall be routed parallel to or perpendicular to building lines, in a neat and workmanlike manner. Any excess cable shall be coiled and supported independently of the ceiling grid system at intervals not exceeding 3 feet. Said cables shall not lie on the ceiling tiles. These same requirements shall apply to cables placed below raised floors.

Penetrations, Sleeves and Seals

Scanning for electrical conduits shall be performed prior to core drilling concrete floors.

- Use a Hilti Ferroscan or similar impulse induction type scanner capable of detecting both metallic conduits and copper wires in PVC conduits. Tracers that scan for energized cables or that scan for injected high frequency signals are not acceptable.
- Notify the Owner's Inspection Department prior to all tests.
- Prior to core drilling, arrange for the Owner's Representative to notify building occupants of the potential for an unscheduled power outage.
- Conduits damaged during core drilling shall be restored immediately at the Contractor's expense.
- Penetrations shall be cut neatly and to the minimum size required for installation of the equipment and raceways.

Galvanized steel pipe sleeves shall be provided for conduits penetrating floors, exterior walls and roofs. As an alternative in floors, a Hilti CP680 Cast-In Firestop Device may be used.

- Extend floor sleeves above the floor a minimum of 2 inches.
- Embed sleeves in new concrete or step-core concrete and grout sleeves into existing concrete with epoxy grout.
- Seal floor sleeves using fire-sealing systems approved by a Nationally Recognized Testing Laboratory.
- Seal exterior wall and roof penetrations water tight.

Conduit penetrations in walls shall be patched on both sides to seal against the passage of air, sound, smoke, and fire.

- Seal conduit penetrations in fire rated walls using fire-sealing systems approved by a Nationally Recognized Testing Laboratory.
- Seal conduit penetrations in non-rated walls using masonry materials that match the wall construction.

Cable tray penetrations in fire rated walls shall be sealed using fire sealant bag or brick systems approved by a Nationally Recognized Testing Laboratory.

Recessed outlet boxes, located less than 24 inches apart, on opposite sides of a fire rated wall, with box openings over 16 square inches, shall both be fire sealed.

Identification

Systems and equipment shall be provided with nameplates indicating their name or number, and power source. Nameplates shall be engraved 1/8-inch thick plastic with black letters on a white background, and letters at least 1/4 inch high. Nameplates shall be attached with a minimum of two mechanical fasteners such as sheet metal screws or bolts and nuts. Embossed plastic tape labels are not acceptable.

Receptacle and switch plates shall be labeled to indicated panel and circuit serving the device. Also mark the same circuit information, inside the outlet box, using indelible ink. "Black on clear Dymo", tape markers, are acceptable for this requirement

Junction boxes and box covers of special circuits shall be color coded as follows:

- Emergency power and Fire Alarm Circuits: Red Paint
- Temperature Control Circuits: Blue Paint
- Clock Circuits: Orange Paint

Junction box covers shall be marked in indelible ink, with the panel name, and breaker numbers of the circuits contained within.

Conduits and cables in the University tunnel system shall be banded at major changes in direction, junctions, entrances to buildings and every 25 ft on straight runs. Banding shall be tape similar to Scotch #33 electrical tape, which is suitable for high temperatures.

- Electrical Power: Red
- Clock System: Red with Purple
- Radio System: Red with Silver
- Computer System: Red with Yellow
- High Voltage: Red