**SECTION 26 05 33**

**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

**BASED ON DFD MASTER ELECTRICAL SPEC DATED 03/01/23**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

Generally, all systems are required to be in conduit or surface raceway.

This section includes language relevant to multiple divisions of work (26, 27 and 28) and may be referenced in specification sections for those divisions of work. Coordinate content with those sections and, where applicable, the designers responsible for those sections.

**PART 1 - GENERAL**

**SCOPE**

This section describes the products and execution requirements relating to furnishing and installing raceways and boxes and related systems as part of a raceway system for electrical, communications, and other low-voltage systems for the project. Included are the following topics:

PART 1 - GENERAL

 Scope

 Related Work

 References

 Submittals

PART 2 - PRODUCTS

 General

 Rigid Metal Conduit (RMC) and Fittings

 PVC Coated Rigid Metal Conduit

 Intermediate Metal Conduit (IMC) and Fittings

 Electrical Metallic Tubing (EMT) and Fittings

 Flexible Metal Conduit (FMC) and Fittings

 Liquidtight Flexible Metal Conduit (LFMC) and Fittings

 Electrical Nonmetallic Tubing (ENT) and Fittings

 Rigid Polyvinyl Chloride Conduit (PVC) and Fittings

 Fiberglass Resin Conduit (RTRC) and Fittings

 High Density Polyethylene Conduit (HDPE) and Fittings

 Conduit Supports

 Surface Metal Raceway

 Surface Nonmetal Raceway

 Multi-Outlet Assembly

 Auxiliary Gutters (Wireways)

 Conduit Water Sealant

 Pull and Junction Boxes

 In Grade Handholes and Boxes

 Outlet Boxes

 Outlet Box Extenders

 Floor Boxes

 Poke-Through Assemblies

 Boxes for Audio-Video Equipment

 Boxes for Fire Alarm Audio-Visual Notification Appliances

PART 3 - EXECUTION

 Conduit Sizing, Arrangement, and Support

 Conduit Installation

 Conduit Installation Schedule

 PVC Coated Rigid Metal Conduit Installation

 High Density Polyethylene Conduit (HDPE) Installation

Surface Metal Raceway and Multi-Outlet Assembly Installation

 Nonmetallic Surface Raceway Installation

 Auxiliary Gutters (Wireways) Installation

 Coordination of Box Locations

 Pull and Junction Box Installation

 In Grade Handholes and Boxes

 Outlet Box Installation

 Floor Box Installation

 Audio-Video System Box and Conduit Installation

 Construction Verification Items

***Where applicable, include the following sentence:***

Supplementary content relating to Audio-Video Systems can be found in specification Section 27 05 33.41 – Raceway and Boxes for Audio-Video Systems.

**RELATED WORK**

***Edit to include applicable sections.***

Applicable provisions of Division 1 govern work under this section.

Section 01 91 01 or 01 91 02 – Commissioning Process

Section 26 08 00 - Commissioning of Electrical.

Section 26 05 26 – Grounding and Bonding for Electrical Systems

Section 26 05 29 – Hangers and Supports for Electrical Systems.

Section 27 05 33.41 – Raceway and Boxes for Audio-Video Systems

Section 26 05 34 -- Underground HDPE Pathways for Electrical Systems

Section 26 27 02 – Equipment Wiring Systems.

Section 26 27 26 – Wiring Devices.

Section 27 10 00 - Structured Cabling

Section 27 41 00 - Audio-Video Systems

Section 28 31 00 – Fire Detection and Alarm.

**REFERENCES**

Wisconsin Administrative Code SPS 316 - Electrical

ANSI/TIA-569-C-Telecommunications Pathways and Spaces

ANSI/SCTE 77-2017 – Specifications for Underground Enclosure Integrity

**SUBMITTALS**

Surface Raceway System - submit product data and catalog sheets for all components.

Boxes - provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

Conduits in Concrete Slabs Above Grade - provide proposed conduit routing and sizing to Structural Engineer prior to approval of installation to verify structural integrity and fire rating of concrete slab.

Mockups -- Provide on request, mockups for Floor Box and Poke-through Assemblies to demonstrate configuration, capacity and aesthetics and to set quality standards for fabrication and installation. Coordinate with Division 26 and Division 27 requirements as applicable to include all power and communications devices.

**PART 2 - PRODUCTS**

***The consultant should review the project requirements and delete the paragraphs that do not apply to this project.***

**GENERAL**

All steel fittings and conduit bodies shall be galvanized.

All conduit transitional fittings shall be listed for installed application.

Condulet fittings shall be threaded rigid entering condulets.

No cast metal or split-gland type fittings permitted.

All condulet covers must be fastened to the condulet body with screws and be of the same manufacture.

Mogul-type condulets 2 inch (50 mm) and larger, shall be permitted.

C-condulets shall not be used in lieu of pull boxes.

All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

**RIGID METAL CONDUIT (RMC) AND FITTINGS**

Conduit: Heavy wall threaded, galvanized steel.

Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

**PVC COATED RIGID METAL CONDUIT**

PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.

Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

**INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS**

Conduit: Galvanized [Steel] [Aluminum], threaded.

Fittings and Conduit Bodies: Use all [Steel] [Aluminum] threaded fittings and conduit bodies.

Expansion Fittings/Expansion Joints: Expansion Fittings shall be Internal Grounding type and shall not rely on external bonding jumpers to maintain grounding continuity between raceway components.

Aluminum conduits shall not be in direct contact with concrete.

**ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS**

Conduit: Steel, Unthreaded thin wall galvanized tubing.

Fittings: All steel, compression or set screw type. No push-on or indenter types permitted.

Transitional fitting: ½-1”: All steel and malleable iron; 1 ¼” and above: All steel, Malleable iron and Die cast where not subjected to physical damage and with project specific DFDM electrical inspector approval.

Conduit Bodies: All steel conduit bodies.

**FLEXIBLE METAL CONDUIT (FMC) AND FITTINGS**

Conduit: steel, galvanized, spiral strip.

Fittings and Conduit Bodies: All steel, galvanized or malleable iron (except as allowed in specification 26 51 13).

**LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC) AND FITTINGS**

Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

**ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS**

Conduit: ENT (smurf tube), UL listed and NEC recognized.

Fittings: One piece quick connect fittings for 1/2 inch to 1 inch size and schedule 40 cemented fittings for larger size. When installed in concrete, fittings shall be suitable for damp locations and shall be concrete–tight, stub-ups and stub-downs kits shall meet manufacturer’s recommendations.

**RIGID POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS**

Conduit: Rigid non-metallic conduit, Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 900 C conductors. Schedule 80 for locations exposed to physical damage or as required.

Fittings and Conduit Bodies: NEMA TC 2, Listed.

**FIBERGLASS RESIN CONDUIT (RTRC) AND FITTINGS:**

Conduit: Reinforced Thermosetting Resin Conduit RTRC, Type AG (Above Ground) and XW (Exposed), and UL 2515 AG (Above Ground) or UL 2420 BG (Below Ground) listed.

The conduit shall be free from defects including delamination’s, foreign inclusions, etc. It shall be nominally uniform in color, density, and physical properties. It shall be straight and the ends shall be cut square to the inside diameter. The resin system shall be epoxy anhydride-cured with no fillers. Glass shall be (E-type or E-CR).

***The A&E shall review the following: glass type selection should consider the following: low smoke vs no smoke and what temperature the fiberglass needs to handle.***

Joining Methods: Interference Joint – the conduit shall be supplied with an integrally wound tapered bell and machine tapered spigot which shall provide a concrete tight and watertight fit with a minimum pullout strength of 500 lbs. when tested in accordance with ASTM D 2105.

Fittings: A complete line of fittings, adaptors, and elbows shall be available and shall be manufactured from the same materials and process as the conduit.

***The A&E shall review the following: fittings are recommended in lieu of factory offsets because factory offsets do not comply with minimal bending NEC bending radius for conduit.***

Sizes: Conduit and fittings shall be manufactured to IPS and ID trade sizes.

Flammability: Conduit and fittings shall conform with UL 2515.

Hangers and Supports: When supporting or hanging conduit on a wall or structure, the manufacturer supplying the conduit shall also supply the hangers and supports. Third party materials shall not be allowed.

Thermal:

Conduit and fittings shall conform with the following:

Heat Deflection Temperature: 312° F per ASTM D 648

Continuous Operating Temperature -40° to 250° F (-40° C to 110° C)

Maximum Operating Temperature -60° to 260° F (-60° to 130° F)

Coefficient of Thermal Expansion 1.25 x 10-5 in/in/F per ASTM D 696

Impact Resistance: Conduit and fittings shall conform with minimum impact resistances as required by UL 2515.

Compression Resistance: Conduit shall not decrease by more than 25% during testing set forth in UL 2515.

Pipe Stiffness: Conduit stiffness shall meet or exceed the standards set forth in ASTM D2412.

**HIGH DENSITY POLYETHYLENE CONDUIT (HDPE) AND FITTINGS**

See specification Section 26 05 34 -- Underground HDPE Pathways for Electrical Systems

**CONDUIT SUPPORTS**

See specification Section 26 05 29.

**SURFACE METAL RACEWAY**

Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.

Size: [[\_\_\_\_\_x\_\_\_\_\_] inch ([\_\_\_\_\_x\_\_\_\_\_] mm).] [As shown on Drawing.]

Finish: [Ivory] [\_\_\_\_\_] enamel.

Fittings: Couplings, elbows, and connectors designed for use with raceway system.

Boxes and Extension Rings: Designed for use with raceway systems.

**SURFACE NONMETAL RACEWAY**

Description: Nonmetallic channel with fitted cover, suitable for use as surface raceway.

Size: [[\_\_\_\_\_x\_\_\_\_\_] inch ([\_\_\_\_\_x\_\_\_\_\_] mm).] [As shown on Drawing.]

Color: [Ivory] [\_\_\_\_\_]

Fittings: Couplings, elbows, and connectors designed for use with raceway system.

Boxes and Extension Rings: Designed for use with raceway systems.

**MULTI‑OUTLET ASSEMBLY**

Description: Sheet metal channel with fitted cover, [with pre‑wired receptacles,] suitable for use as a multi‑outlet assembly.

Size: [[\_\_\_\_\_x\_\_\_\_\_] inch ([\_\_\_\_\_x\_\_\_\_\_] mm).] [As indicated on Drawing.]

Receptacles: Provide covers and accessories to accept convenience receptacles [specified in Section 26 27 26.] [Type 5‑20R, single receptacle.]

Finish: [Ivory] [\_\_\_\_\_] enamel.

Fittings: Couplings, elbows, [outlet and device boxes,] and connectors designed for use with multi‑outlet system.

**AUXILIARY GUTTERS (WIREWAYS)**

Description: [General purpose] [Oil‑tight and dust‑ tight] [Rain-tight] type wireway without knockouts.

Size: [4 x 4] [6 x 6] [8 x 8] [12 x 12] inch ([100 x 100] [150 x 150] [200 x 200] [300 x 300] mm) [As indicated on Drawings]; length as indicated on Drawings.

Cover: [Hinged] [Screw applied] cover [with full gasketing.]

Connector: [Slip‑in construction;] [Flanged;] [hinged cover.] [screw applied cover.]

Fittings: Lay‑in type with [removable top, bottom, and side; captive screws.] [drip shield.]

Finish: Rust inhibiting primer coat with gray enamel finish.

**CONDUIT WATER SEALANT**

Description: Conduit sealant used to prevent water from entering buildings via conduits.

Sealant shall seal conduits against water and gas intrusion, such as Polywater® FST™-250 Foam Duct Sealant, Raychem RDSS Rayflate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).

Manufacturer names and catalog numbers are used to develop quality and performance requirements only. Products manufactured by others may be acceptable provided they meet or exceed the specifications.

**PULL AND JUNCTION BOXES**

Interior Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot-welded joints and corners.

Interior Sheet Metal Boxes larger than 12 inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover. Boxes 9 square-feet or larger shall have hinged covers and a single cover shall not exceed 10 square-feet.

Interior Sheet Metal Boxes connected to an exterior underground raceway, shall have a drain fitting located in the bottom.

Exterior Boxes and Wet Location Installations: Type 4 and Type 6, flat‑flanged, surface‑mounted junction box, UL listed as rain-tight. [Galvanized cast iron][Aluminum][PVC] box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Boxes installed in Parking Ramps shall be Type 4X, flat-flanged, surface-mounted junction box, ETL listed as rain-tight. [Stainless Steel] box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

Box extensions and adjacent boxes within 48 inches of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6 inch-by-6 inch or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

**IN GRADE HANDHOLES AND BOXES**

Handholes and Boxes: [Fiberglass] [HDPE (High Density Polyethylene)] [Polymer- Concrete].

***Polymer-concrete is the default choice and DFDM Preference for communications***.

Handhole and Box Covers: [Fiberglass] [HDPE (High Density Polyethylene)] [Polymer- Concrete] [Galvanized].

Handhole and box bottoms: [Open] [Closed] [Integral Closed].

Handholes and boxes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

Handhole and cover Assembly Load Rating: ANSI/SCTE Tier[8][15][22] or better.

Covers: Weatherproof, secured by tamper-resistant locking devices with non-skid finish.

Cover Label: [BLANK][ELECTRIC][SIGNAL]COMMUNICATIONS][FIBER OPTICS][other]

Units shall be designed – typically with a flared wall and footed base – to prevent frost heaving.

**OUTLET BOXES**

Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.

Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.

Concrete Ceiling Boxes: Concrete type.

Cast Boxes: Cast ferroalloy or aluminum, deep type, gasketed cover, threaded hubs.

**OUTLET BOX**

Outlet Box Extenders: Non-Metallic, adjustable depth.

Outlet Box Extenders may only be used in limited applications with the pre-approval of the State of Wisconsin DFD Electrical Inspector. See Part 3 – Execution for examples of applications of where Outlet Box Extenders may be allowed.

***The A/E shall specify for reference only each type of floor box (make/model) proposed on this project. Provide Floor Box Schedule identifying types and associated devices for each different application.***

**FLOOR BOXES**

Floor Boxes for Installation in Cast‑In‑Place Concrete Floors: [Fully-adjustable,] [Semi‑adjustable,] [cast iron.] [formed steel.] [PVC.] [As indicated on drawings.] Provide boxes with sufficient capacity to house the devices indicated on the plans.

Type: [Flush service] [Concealed service] [Flush or Concealed service as indicated on drawings].

Floor Box Cover: [Solid Aluminum with Brushed Finish] [Solid Brass with Brushed Finish] [Powder coat painted aluminum] [Polycarbonate. Color to be selected by Architect] [As indicated on drawings]. Floor plates shall meet and exceed UL scrub water exclusion requirements for concrete, tile, carpet, and wood covered floors.

Device Plate: Stainless steel or as available from manufacturer.

Configuration: As indicated on drawings.

***Consultant to* *write the performance specification for the items listed below.***

**POKE‑THROUGH ASSEMBLIES**

Description: [Assembly comprising of service fitting, poke‑through component, fire stops and smoke barriers, and junction box for conduit termination] [\_\_\_\_\_].

Fire Rating: Two-hour rated, or rated to match existing floor.

Type: [Pedestal] [Flush] [Concealed Service] [As indicated on drawings].

Floor Plate: [Solid Aluminum with Brushed Finish] [Solid Brass with Brushed Finish] [Powder coat painted aluminum] [Polycarbonate. Color to be selected by Architect] [As indicated on drawings]. Floor plates shall meet and exceed UL scrub water exclusion requirements for concrete, tile, carpet, and wood covered floors.

Device Plate: Stainless steel or as available from manufacturer.

Configuration: As indicated on drawings.

**BOXES FOR FIRE ALARM AUDIO-VISUAL NOTIFICATION APPLIANCES**

Recessed boxes for Fire Alarm audio, visual, and audio-visual notification appliances shall be galvanized steel sheet metal with stamped knockouts. Boxes shall be painted red.

For surface mounting, use manufacturer supplied back boxes and trim plates, painted red or off white to match device color, and shall contain no visible conduit knock-outs. Mark each device with its circuit number.

**PART 3 - EXECUTION**

**CONDUIT SIZING, ARRANGEMENT, AND SUPPORT**

EMT is permitted to be used in sizes 4 inch (100 mm) and smaller for power and low-voltage systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (16 mm) minimum except **all homerun conduits shall be 3/4 inch (21 mm),** or as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

***One-inch (1”) conduit for communications outlets is the default choice. Larger 1 1/4” conduit (or multiple 1” conduits to a box) may be considered where count and/or size of the cabling serving a telecommunications or audio-video outlet merit its use. A/E shall confirm that the planned cable types do not exceed 40% conduit fill.***

Size communications and other low-voltage systems raceways as follows:

Communications, including Equipment Outlet Box: [1] [1 1/4] inch minimum. Conduit used for single device locations (e.g. Wireless Access Point, Video Surveillance Camera, and Wall mounted telephone) may be 3/4 inch minimum.

Control, security, signal, and other low-voltage applications (not including AV): 1/2 inch minimum.

Audio-Video (where applicable): see specification Section 27 05 33.41.

Fire Alarm: 1/2 inch minimum.

Floor Box and Poke-Through Assemblies:

 Power: 3/4 inch minimum or as indicated on drawings.

 Low-voltage: 1 inch minimum or as indicated on drawings.

***Edit language regarding extent of conduit at telecommunications outlet to match project requirements.***

***Verify that cable fill in conduit for communications does not exceed 40% based on the maximum number of cables anticipated (including future use) and nominal assumed cable outside dimension of 0.25 inches.***

Provide one raceway from each communications outlet box [to above accessible ceiling] [to cable tray].

Arrange conduit to maintain 6’-8” clear headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.

Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay‑in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.

Group conduit in parallel runs where practical and use conduit rack (lay‑in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.

Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, other conduits, etc., unless so approved or detailed.

Conceal all conduits except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.

Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

For indoor and exposed exterior conduits, no continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

For exterior below grade conduits, no continuous conduit run shall exceed 250 feet (75 meters) without hand hole, manhole or pull box without project specific DFDM electrical inspector approval.

All conduits installed in exposed areas shall be installed with a box offset before entering box.

**CONDUIT INSTALLATION**

Cut conduit square; de-burr cut ends.

Conduit shall not be fastened to the corrugated metal roof deck nor drywall or suspended ceiling grids.

Bring conduit to the shoulder of fittings and couplings and fasten securely.

Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations.

Threads cut in the field, and factory threads of conduit and nipples not coated with corrosion protection, shall be coated with an approved electrically conductive compound per NEC 300.6.

Corrosion inhibitor, when used in the food service environment, shall be approved for Food Service locations.

Terminate all conduit (except for terminations into conduit bodies) using conduit hubs, or connectors with one locknut, or utilize double locknuts (one each side of box wall).

Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 26 05 26 – Grounding and Bonding for Electrical Systems for grounding bushing requirements.

Provide insulated bushings where raceways contain 4 AWG or larger conductors.

Communication and Low Voltage systems conduits shall terminate in horizontal plane.

Use pendants supported from swivel hangers in exposed ceiling/ structure locations where necessary to mount boxes supporting luminaires and wiring devices. Installation method shall comply with NEC 314.23 (H).

Install no more than the equivalent of the following for building:

 Three 90 degree bends between boxes for electrical systems.

Two 90 degree bends between boxes for communications and other low voltage systems. Note: Offsets shall be considered 90 degrees.

No single bend may exceed 90 degrees.

Use hydraulic one‑shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.

Bend conduit according to manufacturer’s recommendations. Torches or open flame shall not be used to aid in bending of PVC conduit.

Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

Install listed expansion‑deflection fitting or other approved means shall be used where a raceway crosses a structural joint for expansion, contraction or deflection, used in buildings, bridges, parking garages or other structurers.

**Install expansion joints where direct-buried conduit is subject to Earth Movement by settlement or frost per NEC 300.5(J), especially where conduit exits the ground exposed and enters a box, cabinet, or enclosure attached to a building or structure.**

Install expansion fitting in exterior PVC conduit runs per NEC table 352.44 utilizing a minimum temperature change of 120 degree F.

Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide condulet or box with duct seal or other means to prevent the passage of moisture and water vapor through the conduit.

Route conduit through roof openings for piping and ductwork where possible.

Where communication cabling is to be installed in conduit to the wiring hub (e.g. Telecom Room), multiple conduits may be consolidated into fewer, larger conduits. Capacity of shared conduits shall equal the capacity of the individual conduits unless otherwise noted.

Use NRTL listed metallic grounding clamps when terminating conduit to cable tray.

Ground and bond conduit under provisions of Section 26 05 26.

Conduit is not permitted in any slab topping of two inches (50 mm) or less.

***The following paragraph should be used if conduit is allowed in floor slabs in the Project. “The Electrical Engineer must verify with the Structural Engineer that conduit will be permitted in the slab and that the slab is appropriately designed to accommodate the conduit. Limitations other than those listed below must be added to the following paragraph if the Structural Engineer deems it necessary. Also verify with the Architect that conduit will be permitted in the slab and it does not affect the floor fire rating.***

Conduits in Concrete Slab Above Grade: Provide proposed conduit routing and sizing to Structural Engineer for approval prior to installation to verify structural integrity and fire rating of concrete slab.

Maximum Size Conduit in Concrete Slabs Above Grade: 1 inch (25 mm). Do not route conduits to cross each other in slabs above grade. Minimum conduit spacing shall be 6 inches on center.

PVC conduit in concrete pole bases shall transition to galvanized rigid metal conduit 12 inches before it enters a concrete pole base. Inside the pole base, the elbow shall be galvanized rigid metal conduit. From the elbow, the conduit shall transition back to PVC as it continues up and out the top of the concrete pole base.

PVC conduit shall transition to galvanized rigid metal conduit before it enters a foundation wall or up through a concrete floor.

PVC conduit shall be allowed without need of transition to galvanized rigid metal conduit up through concrete floor and concrete equipment pads for pad mounted transformers and switchgear. Provide a PVC connector and bushing, or bell-ends, on each conduit entry. Coordinate conduit installation with submittals and shop drawings for transformers and switchgear.

PVC conduits installed in exposed parking ramps shall have expansion fittings installed per NEC table 352.44, utilizing a minimum temperature change of 110 degrees F. Each conduit run shall be provided with a minimum of one expansion fitting. Proper PVC clamps shall be utilized to allow for conduit movement.

Identify conduit under provisions of Section 26 05 53.

All Aluminum conduits shall not be in direct contact with concrete.

All conduit installed underground (exterior to building) shall be buried a minimum of 24 inches below finished grade, whether or not the conduit is concrete encased. Install warning tape 12" below finish grade over all buried conduits. Underground warning tape shall be detectable, 2” wide minimum, 5 mil thickness, containing a foil core. Tape color shall be red and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" as manufactured by Presco or similar.

**Conduits penetrating underground foundation walls: Individual conduits or each conduit as part of a ductbank penetrating underground foundation walls (excluding manholes) shall be sealed against water intrusion into the building.**

Clean PVC conduit with solvent, and dry before application of glue. The temperature rating of glue/cement shall match weather conditions. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturer’s recommendations.

**CONDUIT INSTALLATION SCHEDULE**

***Edit this article carefully; restrict material application as need to match project needs. This conduit installation schedule may be included on Contract Drawings.***

***Consultant: In prisons or similar applications, a separate rigid steel conduit system shall be specified for all security systems in locations potentially accessible to inmates, including door and lock controls, intercom paging, monitoring and video systems. Consultant shall edit the specification accordingly.***

Conduit other than that specified below for specific applications shall not be used.

* Horizontal Directional Drilling (Directional Boring) Installations: HDPE conduit.
* Underground Installations That Penetrate Foundation Walls: Rigid metal conduit within five feet (1.5 m) of the foundation wall. Conduit may transition to Fiberglass Resin Conduit (BG) or PVC conduit five feet (1.5 m) from the foundation walls.
* Underground Installations That Do Not Penetrate Foundation Walls: Rigid metal conduit, Fiberglass Resin Conduit (BG), or PVC conduit.
* Underground Installations Emerging from Grade: Buried conduit emerging from grade shall be Rigid metal conduit extending from the minimum cover distance of 24 inches below grade to the conduit termination point above grade. Refer to DFD detail.
* Underground Installations Under Concrete Slab: Rigid metal conduit or Schedule 40 PVC conduit.
* Underground Installations Emerging through Concrete Slab: Rigid metal conduit.
* Concealed in Poured Concrete Walls: Rigid Metal Conduit, PVC conduit, or Electrical Nonmetallic Tubing (ENT).
* Concealed in Concrete Block Walls: Electrical metallic tubing, PVC conduit. Electrical Nonmetallic Tubing (ENT).

***Verify with structural engineer and architect whether conduit is permitted within slab.***

* Within Concrete Slab: Rigid Metal conduit or PVC conduit.
* Emerging from Within Concrete Slab: Rigid Metal conduit.
* Exposed Outdoor Locations: Rigid Metal conduit, Intermediate Metal conduit.
* Exposed within Parking Structures: Rigid Metal conduit, Intermediate Metal conduit, PVC conduit.
* Steam Tunnels, Steam Pits or Exposed in Manholes: Aluminum Rigid Metal Conduit [Fiberglass Resin Conduit (XW)].
* Steam Tunnels, Steam Pits Penetration Stub: Schedule 40 PVC
* Wet Interior Locations: Exposed: [Rigid metal conduit] [Schedule 80 PVC conduit] [PVC coated Rigid metal conduit] [Fiberglass Resin Conduit (XW)].
* Concealed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing, PVC conduit (Ground conductor).
* Interior Building Grounding Electrode Conductor: Schedule 80 PVC.
* Exposed Dry Interior Locations: Rigid metal conduit, Intermediate metal conduit, Electrical metallic tubing.
* Motor and equipment connections: Liquidtight flexible metal conduit (LFMC) in all locations except in Mechanical equipment plenum spaces where Flexible Metal Conduit (FMC) shall be utilized. Minimum length shall be one foot (300 mm); maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
* Exposed Dry Interior Locations for HVAC control devices with Conduit Connections: Electrical metallic tubing, Flexible Metal Conduit (FMC). For FMC installations, Minimum length shall be one foot (300 mm), Maximum length shall be three feet (900 mm). Minimum size FMC of 3/8”.
* Exposed Dry Interior Locations for HVAC control devices without Conduit Connections: Where HVAC equipment control panels or devices do not provide for the direct connection of conduits, exposed Class 2 wiring may be extended to complete the final connections in dry locations, provided it does not exceed 18 inches in length.
* Light fixtures: Refer to specification section 26 51 13.
* Plenum Spaces: Installation shall comply with requirements of NEC 300.22.
* Medium Voltage Applications (Interior Locations): Rigid metal conduit (RMC).

**PVC COATED RIGID METAL CONDUIT INSTALLATION**

Installers of PVC Coated Rigid Metal Conduit shall be factory trained and certified in the proper installation methods for this type of conduit. Proof of such certification shall be kept on the project site at all times and shall be produced upon request.

**HIGH DENSITY POLYETHYLENE CONDUIT (HDPE) INSTALLATION**

See specification Section 26 05 34 -- Underground HDPE Pathways for Electrical Systems

**SURFACE METAL RACEWAY AND MULTI‑OUTLET ASSEMBLY INSTALLATION**

Use flat‑head screws to fasten channel to surfaces every twenty-four (24) inches. Mount plumb and level.

Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.

Fastener Option: Use clips and straps suitable for the purpose.

**NONMETALLIC SURFACE RACEWAY INSTALLATION**

Use flat headed screws with appropriate anchors to fasten channel to surfaces secured every twenty-four (24) inches. Mount plumb and level. All surface mounted devices shall be fastened to the wall utilizing flat head screws along with appropriate anchors. No device shall be adhered to the wall surface using two-faced tape or any means other than as described above.

Use suitable insulating bushings and inserts at connections to outlets and corner fittings.

In areas where the walls cannot be fished, the station cable serving these outlets shall be covered with raceways. No exposed wire shall be permitted within offices, laboratories, and conference rooms or like facilities.

Non-metallic raceway shall have a screw applied base. Both the base and cover shall be manufactured of rigid PVC materials.

The raceway shall originate from a surface mounted box mounted adjacent to and at the same height as existing electrical boxes in the room, be attached to the wall and terminate above the ceiling.

All fittings including, but not limited to, extension boxes, elbows, tees, fixture bodies shall match the color of the raceway.

The raceway and all systems devices shall be UL listed and exhibit nonflammable self-extinguishing characteristics, tested to specifications of UL94V-0.

In raceway for communications and other low voltage systems, the inside bend radius minimum shall be as follows:

* Internal diameter of 2 in or less- 6 times the internal diameter.
* Internal diameter of more than 2 in- 10 times the internal diameter.

Conduit bends shall contain no kinks or other discontinuities.

**AUXILIARY GUTTERS (WIREWAYS) INSTALLATION**

Bolt auxiliary gutter to wall using two‑piece hangers or steel channels fastened to the wall or in self‑supporting structure.

Gasket each joint in oil‑tight gutter.

Mount rain-tight gutter in horizontal position only.

Maintain grounding continuity between raceway components to provide a continuous grounding path under provisions of Section 26 05 26.

**COORDINATION OF BOX LOCATIONS**

Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough‑in.

No outlet, junction, or pull boxes shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.

Conduit and boxes shall not be fastened to the metal roof deck. If conduit and boxes are required to be located and installed on roof decks, the conduit and boxes are required to be spaced minimum 1-5/8 inch off the lowest part of the metal roof decking material, per NEC 300.4 (E).

It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.

In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Architect/Engineer and install outlet as instructed by the Architect/Engineer.

The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.

Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors. Boxes must be installed within 12” from edge of the access door.

Locate and install to maintain headroom and to present a neat appearance.

Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

Boxes installed in the building envelop shall be sealed with caulking materials or closed with gasketing systems compatible with the construction materials and locations per IEC 502.4.3.

**PULL AND JUNCTION BOX INSTALLATION**

Pull boxes and junction boxes shall be minimum 4 inches square (100 mm) by 2 1/8 inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit, minimum junction box size shall be 4 11/16 inches square by 2 1/8 inches deep.

Where used with raceway(s) containing conductors of 4 AWG or larger, pull box shall be sized as required unless otherwise noted on the drawings.

Where used with raceway(s) containing conductors on systems over 600V, size pull box per NEC 314 Part IV unless otherwise noted as larger on the drawings.

 Size pull boxes for communications per ANSI/TIA-568-C

Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install DFD approved access panels in non-accessible ceilings where boxes are installed. All boxes are to be readily-accessible.

Provide Pull and Junction boxes for communications and other low voltage applications (a) in any section of conduit longer than 100 feet, (b) where there are bends totaling more than 180 degrees between pull points or pull boxes and (c) wherever there is a reverse bend in run. Locate boxes on straight section of raceway (e.g. do not use boxes in place of raceway bends).

Support pull and junction boxes independent of conduit.

**IN GRADE HANDHOLES AND BOXES**

Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

Unless otherwise indicated and detailed, support units on a level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.25 mm) sieve and compacted to same density as adjacent undisturbed earth.

Elevation: In finished areas, set so cover surface will be flush with finished grade.

Unless approved by DFD review staff, handholes and boxes shall **NOT** be installed in paved or concrete drives or walks.

Units shall be selected with depth sufficient to allow for conductor bending/ wire management and allow sufficient conduit elevation above compacted bed to prevent water infiltration in conduit.

Provide four (4) sets of the tool(s) required to access tamper resistant locking covers. In addition, provide the tool(s) model number to allow for ordering of additional sets. Tools and bits, shall be turned over to owners representative, prior to project closeout.

Provide conduit sealant to seal conduits against water and gas intrusion, such as Polywater® FST™-250 Foam Duct Sealant, Raychem RDSS Rayflate Duct Sealing System, or approved alternate. Sealant shall be re-enterable, shall be compatible with the conduit and conductor types being used, and shall comply with NEC 225.27, 230.8, and 300.5(G).

**OUTLET BOX INSTALLATION**

Do not install boxes back‑to‑back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic‑rated walls.

Power:

Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction, or drywall shall be minimum 4 inch square, with device rings. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes. A single gang box can be used in drywall and masonry, for a single device location, when a single conduit enters box.

Shallow 4 inch square by 1 1/2 inch deep boxes can be used as device boxes for power provided the box and plaster ring is sized for installed device and conductors.

Low Voltage:

***Device ring adds additional depth to bring assembly into compliance with TIA recommendations for minimum 2 1/2 inch depth.***

Recessed (1/4 inch maximum) outlet boxes in masonry, concrete, tile construction or drywall shall be minimum 4 11/16 inch square by 2 1/8 inch deep with single gang device ring (unless noted otherwise on drawings or in companion specifications). Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.

Provide one conduit from each communications Equipment Outlet box. Conduit runs between outlet boxes for communications are not allowed. Terminate conduit [above accessible ceiling] [above accessible ceiling in corridor] [on cable tray] [as detailed on drawings].

Provide knockout closures for unused openings.

Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.

Use multiple‑gang boxes where more than one device are mounted together; do not use sectional boxes. Sectional boxes may only be used with the pre-approval of the State of Wisconsin DFD Electrical Inspector for remodeling applications where it is impractical to install multi-gang boxes. Provide non-metallic barriers to separate wiring of different voltage systems.

Install boxes in walls without damaging wall insulation.

Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

Ceiling outlets shall be 4 inch square, minimum 2 1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans.

In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.

Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

Align wall‑mounted outlet boxes for switches, thermostats, and similar devices.

Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

Outlet Box adjustable ring and depth device applications:

Provide box extenders for boxes that are set too far back in the wall due to un-anticipated wall finishes. Place the box extender over the existing box face to make the box face flush with the wall finish.

**FLOOR BOX INSTALLATION**

Set boxes level and flush with finish flooring material.

Serve communications compartments (Tele/Data and AV) in Floor Boxes with conduit(s) dedicated to each compartment. Conduit runs between floor boxes for communications are not allowed. Conduit shall be part of path that allows for cable to be terminated at wiring hub (e.g. Telecom Room) on same floor on which floor box appears unless noted otherwise.

**AUDIO-VIDEO SYSTEM BOX AND CONDUIT INSTALLATION**

Conduit requirements for AV systems cabling may differ from those of other trades. Where applicable, refer to specification Section 27 05 33.41 – RACEWAY AND BOXES FOR AUDIO-VIDEO SYSTEMS.

**CONSTRUCTION VERIFICATION**

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION