

GUIDELINES

HAS/PDC/Design Division
Houston, Texas

Project Title
Proj./CIP No.

(These Guidelines are basic minimum criteria to be met in preparing the final specifications for this section, which is the responsibility of the Designer/Contractor/Installation Team.)

SECTION 270528 INTERIOR COMMUNICATION PATHWAYS (REV. 03-16-2026-SJS)

PART 1 GENERAL

1.01 PROJECT SCOPE SUMMARY

Designer shall provide a detailed narrative/scope of the tasks to be performed under this specification sections.

1.02 SECTIONS INCLUDES

- A. This section includes specifications for the installation of interior communications pathways.
- B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01- Specification sections, apply to the work of this section.
- C. Interior Communication Pathways are defined to include, but are not limited to innerduct, flexible multi-cell innerduct, conduit, pull boxes, cable/j-hooks, cable trays, supports, accessories, associated hardware and fire stopping materials.

1.03 REFERENCES

- A. Related Sections: Use these Specifications for all related work not specifically covered in this specification.
 - 1. Section 270526: Telecommunication Grounding and Bonding
 - 2. Section 270543: Exterior Communication Pathways
 - 3. Section 270553: Identification and Labeling of Communication Infrastructure
 - 4. Section 271045: Restroom Monitoring System
 - 5. Section 271100: Communication Cabinets and Equipment Rooms
 - 6. Section 271300: Backbone and Riser Media Infrastructure
 - 7. Section 271500: Horizontal Media Infrastructure
 - 8. Section 272100: Data Communication Network Equipment
 - 9. Section 272200: PC, Laptop, Servers and Equipment
 - 10. Section 275113: Audio Communication System
 - 11. Section 281300: Access Control System
 - 12. Section 232313: Video Surveillance Control and Management System
- B. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA): Most current standard revision
 - 1. 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.
 - 2. 568-D, Commercial Building Telecommunications Cabling Standard.

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- C. American National Standards Institute (ANSI):
 - 1. C80.1 Rigid Steel Conduit - Zinc Coated
 - 2. C80.4 Fittings for Rigid Metal Conduit
- D. Federal Specifications (FS):
 - 1. W-C-58C Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron
 - 2. W-C-1094 Conduit and Conduit Fittings Rigid
 - 4. WW-C-581D Coatings on Steel Conduit
- E. Building Industry Consulting Services International (BICSI):
 - 1. Telecommunications Distribution Methods Manual (latest issue)
 - 2. Customer Owned Outside Plant Design Manual (latest issue)
- F. National Electrical Manufacturers Association (NEMA).
 - 1. VE 1-1998 - Metallic Cable Tray Systems
 - 2. VE 2-2000 - Cable Tray Installation Guidelines
 - 3. RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
 - 4. TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
 - 5. TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
- G. Underwriters Laboratories (UL) Cable Certification and Follow Up program
 - 1. UL 6: Rigid Metal Electrical Conduit.
 - 2. UL 514B: Fittings for Conduit and Outlet Boxes.
 - 3. UL 651: Schedule 40 and 80 Rigid PVC Conduit.
 - 4. UL 651A: Type EB and A Rigid PVC Conduit and High-Density Polyethylene (HDPE) Conduit.
 - 5. UL 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- H. American Society for Testing Materials (ASTM).
 - 1. ASTM B633 – specification for Electro-Deposit Coating of Zinc on iron and Steel.
 - 2. ASTM A653 – Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process.
 - 3. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
 - 4. ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low Alloy with Improved Formability (Formerly ASTM A570 & A607)
 - 5. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (Formerly ASTM A611)
- I. National Electrical Code (NEC latest issue).
- J. Institute of Electrical and Electronic Engineers (IEEE).

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K. SYSTIMAX Application Assurance for Structured Cabling Systems (SCS) Latest Revision.

L. International Standards Organization/International

M. Electromechanical Commission (ISO/IEC) DIS 11801

N. Conflicts:

1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
2. Between reference requirements and contract documents: Comply with the one establishing the more stringent requirements.

1.04 SUBMITTALS

- A. Submit Shop Drawings to include but not limited to plan and section drawings detailing proposed communication pathway routing prior to installation. Communication pathway installation plan to include but not limited to:
1. Room penetration plan.
 2. Communication pathway extension plan.
 3. Riser conduit anchoring plan.
 4. Conduit chase plan.
 5. Communication pathway labeling plan.
 6. Junction box, gutter, and pull-box labeling plan.
- B. Shop Drawings shall be submitted and approved before implementation is started. Shop Drawings shall be submitted in accordance with Specification 01340.
- C. Submit prototype test reports for all vault covers verifying conformance to the specification requirements in this document and HAS.
- D. Submit catalog data sheets of conduit, innerduct, raceway, cable tray, cable hook, and associated hardware. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.
- E. Test Reports: Submit certified test reports indicating compliance with material reference standard indicated for material performance characteristics and physical properties of fire stopping materials.
- F. Certificates: Submit product certificates, signed by manufacturer certifying materials comply with specified performance characteristics and physical properties of fire stopping materials.
- G. Copy of Building Industry Consulting Services International (BICSI) Registered Communication Distribution Designer (RCDD) certificate for Contractor's designated project RCDD inspector / supervisor. RCDD shall always supervise all portions of communications installation.

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1.05 QUALITY ASSURANCE

- A. Verify conduit, raceway, cable tray runs, etc. shall not interfere with existing or new systems within each facility.
- B. Fire Stopping: Manufacturer trained and approved installer to perform fire-stopping work who has specialized in the installation of work similar to that required for this project. All penetrations with firestopping products shall have a Firestop Identification Label stating the Underwriters Laboratories (UL) system number, installation date, company name, and project name or number.
- C. Communication Pathway Minimum Clearances:
 - 1. Motors or transformers: 4 feet
 - 2. Power cables and conduits: 1 foot parallel, 3 inches crossover
 - 3. Fluorescent lights: 5 inches
 - 4. Above ceiling tiles: 4 inches (from top of grid to bottom of lowest pathway hardware item – for example: all thread)
 - 5. Minimum Unobstructed Access above cable tray: 12 inches
 - 6. Minimum Unobstructed Access to one side of cable tray: 18 inches.
 - 7. Hot Flues, Steam pipes, Hot water pipes and other hot surfaces: at least 6 inches from bottom or area not within the Minimum Unobstructed Access requirements.
- D. Furnish products of latest proven design, new and in current production. Do not use obsolete components or out-of-production products.
- E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- F. All installed materials and accessories shall be new from the manufacture. No used components shall be accepted by HAS.
- G. All Documentation submittals shall be reviewed by the supervising RCDD and stamped prior to submittal.
- H. Contractor Qualifications:
 - 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 - 2. A BICSI RCDD shall supervise ALL work on-site. Must demonstrate knowledge and compliance with all BICSI, ANSI/TIA/EIA, UL, NEC standards, and codes.
- I. HAS retains the right to have access and inspect all work during the entire duration of the project and any items that do not adhere to the standards, reference, contract, bid, or project documents will be corrected immediately at NO cost to HAS.
- J. All communication media shall be installed in conduit or cable tray unless alternate method

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has been granted prior approval by HAS Technology.

1. Exception: Non-category rated cabling used for Security horizontal media shall be installed in conduit from end devices to MDF/IDF.

PART 2 PRODUCTS

2.01 GENERAL

- A. Where conduit, pull boxes, cable tray and other raceway sizes are not specifically shown on contract drawings. All communication pathways shall be sized in accordance with the requirements of BICSI and the NEC. No conduit shall be less than 1". [Except for those locations specified in the contract documents under section 281300 Access Control with HAS Technology Prior approval.]
- B. All raceways exposed to the elements or possible physical damage or installed below 8 feet shall be Rigid Metal Conduit.
- C. Raceway exposed to elements, not exposed to physical damage and above 8 feet shall be Intermediate Metal Conduit.
- D. Raceways installed in stud walls or above suspended ceilings shall be Electrical Metallic Tubing.
- E. All backbone and riser conduits 3" and greater installed shall be populated with MaxCell flexible innerduct. Cable fill ratio not to exceed 40%.

2.02 CONDUIT AND ACCESSORIES

- A. MANUFACTURES:
 1. Allied
 2. Triangle
 3. Wheatland
- B. Rigid Steel Conduit shall pass all bending, ductility, and thickness of zinc coating in ANSI C80.1 and UL 6. Conduit shall be galvanized have threaded end with 1" minimum size and 4" maximum size. Fittings shall be cast iron or alloy steel, threaded and galvanized. Rigid Steel Conduit shall be of natural color from the manufacturing process.
- C. Intermediate Metal Conduit (IMC) shall be manufactured in accordance with UL 1242. Conduit shall be low carbon, hotdipped- galvanized inside and out, with threaded ends, 1" minimum size, and 4-inch maximum size. Fittings shall be cast iron or alloy steel, threaded

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- and galvanized. Intermediate Metal Conduit shall be of natural color from the manufacturing process.
- D. Electrical Metallic Tubing (EMT) shall be manufactured in accordance with UL 797 and ANSI C80.3. EMT shall be high -strength, zinc-coated, 1-inch minimum size. EMT may be used for sizes greater than 2" where physically protected. EMT shall not be utilized for service entrance conductors. Fittings shall be of same finish and material as tubing. Fittings shall be compression type with insulated throat and threaded plastic or grounding bushings. Electrical Metallic Tubing shall be of natural color from the manufacturing process.
 - E. Aluminum conduit shall not be used.
 - F. Push-on type bushings shall not be used.
 - G. Expansion Joint Fittings: OZ Gedney type AX or Appleton type XJB, watertight, permitting two-way- movement up to 4 inches, equipped with bonding jumpers around or through each fitting.
 - H. Thruwall Sealing Fittings: Type WSK by O-Z Gedney Company.
 - I. Gas-Tight Sealing Bushing: Type CSBE, CSBI, or CSBG by Appleton/OZ Gedney.
 - J. Sealing Material for Sealing Fittings:
 - a. Perma-Cote Chico X fiber Mineral Wool, Chico A or Chico A-P- by Eaton-Crouse Hinds.-
 - b. Appleton sealing cement and fiber filler.
 - ~~K.~~ Insulated Bushings:
 - ~~a.~~ Type B or SBT by O-Z Gedney
 - b. Series BU500 by ABB Thomas & Betts
 - L. Provide a measured pull tape in each empty conduit, empty innerduct for backbone and riser pathways.
 - M. Provide a pull string for all horizontal conduits with a minimum pulling tension of 200 pounds.
 - N. Thread lubricant/sealant shall be Crouse Hinds type STL or Thomas & Betts- Kopr-Shield except, when required- on joints for heat producing elements such as lighting fixtures; it shall be Crouse H-inds type HTL.

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- O. PVC Conduit shall not be used in intercommunication pathways. Except when encased in concrete.

2.03 FLEXIBLE MULTI-CELL INNERDUCT

- A. Manufacturers:
1. MaxCell
 2. Or HAS approved equivalent
- B. Flexible Innerduct
1. Flexible innerduct is the HAS standard for multi-path applications within conduit.
 2. All riser/backbone fiber shall be installed in flexible innerduct.
 3. Flexible Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024A.
 4. All flexible innerduct shall be installed per manufacturer requirements.
 5. Only manufacturer's fittings, transition adapters, terminators, accessories, and installation kits shall be used.
 6. All flexible innerduct will be populated with a measured pull tape.
 7. All interior flexible innerduct shall be plenum rated.
 8. Flexible innerduct shall only be used when installed in conduit and shall consist of a different color for the maxcell.
 9. Flexible innerduct and pull tape shall be independently secured at each end/pull point.
 10. Reusable Termination bags are to be used at each conduit segment endpoint of the Pathway containing Maxcell.

MaxCell 4" 3 Cell

Min Conduit ID	Suggested Product	# of Packs Required	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 4" 3 Cell	1	3	1.34"	1500'	2000'
4"	MaxCell 4" 3 Cell	2	6	1.34"	1500'	2500"
5"	MaxCell 4" 3 Cell	3	9	1.34"	1500'	2500'
6"	MaxCell 4" 3 Cell	4	12	1.34"	1500'	2500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths.

MaxCell 3" 3 Cell

Min Conduit ID	Suggested Product	# of Packs Required	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
3"	MaxCell 3" 3 Cell	2	6	1.03"	1200'	2000'

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4"	MaxCell 3" 3 Cell	3	9	1.03"	1500'	2500"
5"	MaxCell 3" 3 Cell	4	12	1.03"	1500'	2500'
6"	MaxCell 3" 3 Cell	5	15	1.03"	1500'	2500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths.

MaxCell 2" 3 Cell

Min Conduit ID	Suggested Product	# of Packs Required	Max # of Cables	Maximum Cable Diameter per Cell	Rec. Pull Length*	Max Pull Length*
2"	MaxCell 2" 3 Cell	1	3	.70"	800'	1500'

*Use of Optical Fiber Nonconductive Riser (OFNR) cable may result in reduced pulling lengths.

2.04 INNERDUCT

B. Manufacturers:

1. Carlon
2. Pyramid
3. Or HAS approved equivalent

C. Innerduct

1. All non-armored fiber placed in cable tray shall be installed in corrugated innerduct.
2. Minimum size: 1" (one inch) corrugated non-metallic innerduct.
3. Innerduct shall be UL Listed with Flame Propagation compliant with UL 2024.
4. Only manufacturer's fittings, transition adapters, terminators, and fixed bends shall be used.
5. All empty innerduct will be populated with a measured pull tape.
6. Where more than one innerduct is routed in a conduit, each innerduct shall consist of a different color from end to end (ex. Blue, Orange, Green, and Brown). Do not couple innerduct of different colors without HAS prior approval.
7. All interior innerduct shall be plenum rated, unless installed in conduit.

2.05 CABLE TRAYS

A. Manufacturers:

1. B-Line
2. Cope
3. Panduit

B. CABLE TRAY

1. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated; with splice plates, bolts, nuts and washers for connecting units. Construct

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units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

2. Materials and Finish: Material and finish specifications for each tray type are as follows:
 - a. Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
 - b. Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties in accordance with ASTM A653 SS.
 - c. Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All covers and splice plates must also be hot-dip galvanized after fabrication; mill galvanized covers are not acceptable for hot-dipped galvanized cable tray.
 - d. Stainless Steel: Straight section and fitting side rails and rungs shall be made of AISI Type 304 or Type 316 stainless steel.

TYPE OF TRAY SYSTEMS

- A. I-Beam Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 or 12 inches on center. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200-pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.
- B. Ventilated trough type trays shall consist of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable-bearing surface of 2-3/4 inches and shall be spaced 6 inches on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2-1/4 inch by 4-inch rectangular holes punched along the width of the bottom.
- C. All tray sizes and types shall have a minimum of 4" (four inch) usable load depth.
- D. All straight sections shall be supplied in standard 10-foot length, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.
- E. Tray widths shall be 6, 12, 18, 24, or 36 inches. *Designer to specify width per the infrastructure needs.*

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- F. All fittings must have a minimum radius of 12, 24, 36, or 48 inches. *Designer to specify minimum radius per the infrastructure needs.*
- G. Splice plates shall be the bolted type made as indicated below for each tray type. The resistance of fixed splice connections between adjacent sections of tray shall not exceed .00033 ohms. Splice plate construction shall be such that a splice may be located anywhere within the support span without diminishing rated loading capacity of the cable tray.
 - 1. Aluminum Tray - Splice plates shall be made of 6063-T6 aluminum, using four square neck carriage bolts and serrated flange locknuts. Hardware shall be zinc plated in accordance with ASTM B633, SC1.
 - 2. Steel (including Pre-galvanized and Hot-dip galvanized) - Splice plates shall be manufactured of high strength steel, meeting the minimum mechanical properties of ASTM A1011 HSLAS, Grade 50, Class 1. Hardware shall be zinc plated in accordance with ASTM B633 SC1 for pre-galvanized cable trays, or Chromium Zinc in accordance with ASTM F-1136-88 for hot-dip galvanized cable trays.
- H. Cable Tray Support shall be placed so that the support spans do not exceed maximum span indicated on drawings or by the manufacturer. Supports shall be Trapeze style support. Cable trays installed adjacent to walls shall be supported on wall-mounted brackets as specified by the manufacturer.
- I. Trapeze hangers shall be supported by 3/8" (three-eighths inch) minimum diameter all-thread rods.
- J. Accessories shall be furnished as required to protect, support, and install a cable tray system. Accessories shall consist of but are not limited to; section splice plates, expansion plates, blind-end plates, specially designed ladder dropouts, waterfall plates, barriers, etc.
- K. All cable tray components and accessories will be from the same manufacturer. Parts from different manufacturer will not be intermixed.

2.06 CABLE HOOK SYSTEMS (J-Hooks)

- A. Cable hooks are not allowed.
 - a. Exception: Usable within a tenant lease space only with HAS Technology prior approval.

2.07 FIRESTOPPING MATERIALS

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- A. Manufacturers:
 - 1. Johns Manville
 - 2. Hilti
 - 3. 3M
 - 4. Unique
- B. Description:
 - 1. Performance requirements: Provide firestopping systems that are produced and installed to resist spread of fire according to requirement indicated, resist passage of smoke and other gases, and maintain fire resistance rating of assembly.
 - a. F-Rated Systems: in accordance with ASTM E814
 - b. T-Rated Systems: in accordance with ASTM E814
 - 2. Fire stopping flame spread performance requirements: Provide products with Class A fire ratings with flame-spread ratings of less than 25 and smoke development ratings of less than 50 as determined in accordance with ASTM E 84.
 - 3. Fire Stopping UL performance requirements: Provide products with UL ratings specified for assembly indicated as determined in accordance with UL listings.

2.08 PULL BOXES

- A. All pull boxes shall be constructed with a minimum of 14 gauge-galvanized steel with an ANSI 61 grey polyester powder finish inside and out over phosphatized surfaces or galvanizes steel unless otherwise specified.
- B. All pull boxes shall have flat, removable covers fastened with plated steel screws with unique keyhole screw slots in the cover to permit removal of the cover without extracting screws unless otherwise specified.
 - 1. All removable box covers shall be connected to box with a safety strap or chain for all boxes 8" X 8" or larger.
- C. All pull boxes shall be individually supported. Back Boxes are not allowed and shall not be used as support for conduit.
- D. All backbone pull boxes shall provide the appropriate provisioning for bonding and grounding for each conduit connected to the pull box.
- E. All pull boxes shall be NEMA Type 1 and sized according to the NEC for cable fill ratio unless otherwise specified or prior approval by HAS Technology.

Maximum Trade Size of Conduit	Minimum Box Size (inches)	For Each Additional
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(inches)	Width	Length	Depth	Conduit Increase Width (Inches)
1	4	16	3	2
1.25	6	20	3	3
1.5	8	27	4	4
2	8	36	4	5
2.5	10	42	5	6
3	12	48	5	6
3.5	12	54	6	6
4	15	60	8	8

2.09 WALL BACKBOARD

- A. Reference Specification 271100 Section 2.04

PART 3 EXECUTION

3.01 GENERAL

- A. Raceways shall be mechanically and electrically connected to all boxes and fittings and shall be properly grounded per NEC.
- B. The routing and location of all conduits, cable tray, cable hooks and other raceways shall be coordinated with other trades prior to and during building construction to avoid delays and conflicts.
- C. Where raceways pass through walls, partitions and floors, seal penetrations to provide a neat installation, maintain the integrity of the waterproofing or fireproofing, of the structure. Coordinate installation requirements with roofing installer where conduits pass through the roof.
- D. All raceways entering a building from underground shall be sealed to prevent water, moisture, gas, or any other foreign matter from entering the building. Service conduits shall be sealed in accordance with NEC 230.8-.
- E. Contractor's project RCDD supervisor shall review, approve, and stamp all shop drawings, coordination drawings and records drawings.
- F. Do NOT route communication pathways under HVAC condensing units.
- G. Expansion Fittings:

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1. Raceways shall be provided with expansion fitting where necessary to compensate for thermal expansion and contraction.
2. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceways systems

3.02 CONDUIT INSTALLATION

- A. Rigid and IMC shall be installed with threaded fittings and couplings.
- B. All metallic couplings, connectors, and fittings shall be malleable iron or steel and finished with zinc plating or by galvanizing.
- C. All conduits shall be plugged immediately upon installation to prevent the entrance of construction dirt and debris. All conduits shall be swabbed and cleaned before wires are pulled.
- D. Expansion fittings shall be utilized in all cases where conduits pass through building expansion joints. Fittings shall be of an approved weatherproof telescopic type permitting a movement of up to four inches and shall be provided with approved bonding jumpers around or through the fitting.
- E. Connection of Conduit to pull / junction Boxes and Enclosures:
 1. Connection to NEMA 1 type boxes and enclosures:
 - a. Rigid: Install insulated bushings and double locknuts.
 - b. IMC: Install insulated bushings and double locknuts.
 - c. EMT: shall be installed with compression connectors, insulated throats, and threaded plastic or grounding bushings.
 2. Connection to NEMA 3R, 4, 4X, and 12 type boxes: Install insulated bushings and sealing locknuts or hubs.
 3. When conduits enter floor mounted enclosures from below and there is no sheet metal to which to attach; install grounding bushings on the conduit. Bond bushings to ground bus using a conductor the same size as required for an equipment grounding conductor sized for the given circuit.
 4. Install sealing bushing within all conduits which have entered a building From outside, whether from above or below grade.
- F. No section of conduit shall be longer than 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described

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herein is considered a 90 degree bend.

- G. The inside radius of bends in conduit shall be:
 - 1. 6 times the internal diameter for 2" or less.
 - 2. 10 times the internal diameter for greater than 2".
- H. With prior HAS/IT APPROVAL, for conduit runs, a special LBD conduit (Crouse-Hinds or approved equal) may be used for CMU penetration where a swept 90 will not work. LBD condulets are designed for communications cable installation to maintain bend radius requirements.
- I. A pull string (jet-line) shall be installed in all 1" conduit and below.
- J. A measured pull tape with a minimum strength of 200 pounds test shall be placed in all conduits over 1".
- K. Any single conduit run extending from a Telecommunication Room shall not serve more than one outlet.
- L. All communications conduits shall be identified with color coded orange tape marked "Communications" every 50 feet. Tag conduit termination points (to include J-box locations) and wall penetrations (both sides) with the origination and destination location.
Example: **IDF.A4N > CAM.1023**
- M. Conduit shall be reamed to eliminate sharp edges and terminated with an insulated throat connector along with a screw on bushing and/or grounding bushing.
- N. Conduit protruding through the floor shall be terminated at a minimum of 6" (six inches) above the floor surface.
- O. All stubbed conduit ends shall be provided with a ground bushing.
- P. All conduit penetrations shall be provided with the proper conduit sleeves.
 - 1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 - 2. Sleeves shall be installed in the communications room floor or ceiling a minimum of six inches on center from the wall.
 - 3. Conduit floor sleeves shall be spaced to allow space for insulated ground bushing for cable protection.
 - 4. Sleeves shall be installed in a single tier or row from left to right in a straight line.
 - a. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.

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5. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- Q. All cable (horizontal, riser, or backbone) wall or ceiling penetrations shall be provided with the proper conduit sleeves.
1. Sleeves shall extend three inches AFF or four inches below finished ceiling, with a bushing.
 2. Sleeves shall be installed in the floor or ceiling a minimum of two to four inches on center from the wall.
 3. Sleeves shall be installed in the walls at a minimum of two inches extended on each side of the wall.
 4. Cable floor, ceiling, and wall sleeves shall be spaced to allow space for ground bushing and insulated bushing for cable protection.
 5. Shall be installed in a single tier or row from left to right in a straight line.
 6. If two tiers or rows are required, the conduits shall be staggered minimum of 2 inches between tiers.
 7. Cable support anchors shall be installed 18 to 24 inches above the sleeves.
- R. All conduit and cabinet entrances shall be sealed with an approved, re-enterable sealant material to prevent ingress of water, dust or other foreign materials.
- S. Conduit shall not be embedded in the required fire protective covering of a structural member that is to be individually encased in accordance with Building Officials and Code Administrators International, Inc. (BOCA).
- T. Install all exposed conduit parallel or perpendicular to lines of existing construction and grouped together where possible, without interfering with use of premises or working areas. Prevent safety hazards and interference with operating and maintenance procedures.
- U. ALL Conduit Sizing and supports:
1. Support conduit 2 inches and larger at 10 feet on center maximum, and conduit less than 2 inches {1½ inch and smaller} at eight feet on center maximum.
 2. Fasten 1½ inch and smaller conduit to concrete, masonry or steel with either one-hole malleable iron conduit straps, or "Korn" clamps, or U-bolts; for larger diameters, use two-hole straps. Use "clamp backs" for strapping conduits to planar surfaces.
 3. Multiple runs shall be supported on channel adequately secured to walls or hung from structure above with conduits fastened to channel with clamps designed for the purpose.
 4. When installation requires trapeze/rack support minimum 3/8" (three-eighths inch) all-thread shall be used.
 5. When installation requires a single 1" (one inch) conduit, minimum ¼" (one-quarter inch) all-thread shall be used. Hanger wire shall not be used for any installation.

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6. When installation requires single conduit greater than 1" (one inch), 3/8" (three-eighths inch) all-thread shall be used.
7. Cable fill rates should not exceed 40% of the cross-sectional area of the installed conduit.

V. Horizontal Conduit Routes:

1. Horizontal (station) conduit is defined as the conduit run between the communications outlet and the cable tray or communications room as indicated on Drawings.
2. Each horizontal conduit run shall be a one-inch metallic conduit and shall be home run from each communications outlet box to the equipment room, terminating equipment or cable tray, as indicated in Drawings.
3. Each single horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered to be two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with the offset as described herein is considered a 90-degree bend.
4. Each dual horizontal conduit run shall be provided with a junction or pull box every 30m (100ft) or contain more than two 90-degree bends between pull points, pull boxes, or reverse bends. Offset is considered two equal bends in opposite direction, the two angles of which cannot exceed 45 degrees in each direction. In all cases, the two angles comprising the offset shall be considered 90 degrees. Any conduit bends less than 90 degrees and is not associated with an offset as described herein is considered a 90-degree bend. The quantity of conduits entering the junction or pull box shall equal the number of conduits exiting the junction or pull box.
5. Each terminating (outlet end) conduit connection shall be provided with the proper compression with insulated throat and bushing or fitting.
6. Each originating end (communications room end) shall be provided with the proper connecting insulated ground bushing and properly bonded to ground.
7. If flexible conduit is required install must not be longer than 7' (seven feet) and must have HAS/IT approval prior to installation.
8. All conduits shall be independently supported from pull / junction boxes.

W. Horizontal conduit entrance in communications rooms – wall entry

1. Horizontal conduits shall enter the communications room wall 12 to 18 inches above the top of the cable tray. Maintain cable bend radius with supporting device as required.
2. Conduit wall stubs shall be spaced in increments equal to the conduit outside diameter (OD) from each other.
3. All conduit wall stubs shall be extended to the terminating equipment, electronics,

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- or cable tray, as noted in Drawings.
- 4. Conduit crossovers are not permitted.
- X. Horizontal conduit entrance in communications rooms – ceiling entry
 - 1. Horizontal conduits shall enter or be extended from the equipment room ceiling 12 to 18 inches above the top of the cable tray.
 - 2. Ceiling conduit stubs shall be spaced in increments equal to the conduit OD from each other.
 - 3. All ceiling conduit stubs shall be extended to the terminating equipment, electronics, or cable tray, as noted in Drawings.
 - 4. Conduit crossovers are not permitted.
- Y. Horizontal conduit entrance in communications rooms – floor entry
 - 1 Horizontal conduits shall enter the communications room floor two inches to four inches on center from the wall and shall be stubbed 4 inches AFF.
 - 2 Conduit floor stubs shall be spaced in increments equal to the conduit OD from each other.
 - 3 Conduit crossovers are not permitted.
- Z. Horizontal conduit to cable tray
 - 1. No horizontal conduit runs shall be attached to the cable tray in any fashion.
 - 2. Conduit terminating end shall be self-supporting above the cable tray side rail. Not attached. Minimum of 6” (six inches) above the cable tray and not to exceed 12” (twelve inches) above the cable tray.
- AA. Horizontal Junction/Outlet Boxes
 - 1. Each horizontal conduit shall be terminated into an outlet box.
 - 2. Each outlet box shall be a deep four-inch square junction box with a minimum of two one-inch knockouts on each of the sides.
 - 3. Each conduit home run shall be provided with a deep 4-11/16” inch square junction box (w/cover) at 100-foot or 180-degree intervals and six inches above each ceiling and wall intersection.
 - 4. Pull boxes shall not be used as a 90-degree bend in any conduit installation.
- BB. Backbone/Riser conduit entrance in communications rooms – wall entry
 - 1. BB/Riser conduits shall enter the communications room wall a minimum of 24 inches above the top of the cable tray.
 - 2. Conduit wall stubs shall be spaced in increments to equal the conduit OD from each other.
 - 3. BB/Riser conduits shall be installed in a single tier or row from left to right horizontally.
 - a. If two tiers or rows are required, the conduits shall be staggered between tiers.

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- b. No more than two tiers or rows are permitted.
- 4. All conduit wall stubs shall be extended to and over the cable tray to access cable tray pathway.
- 5. All BB/riser conduit stubs shall be provided with the proper universal dropout/ waterfall cable exit runway, which shall be supported by and mounted to channel strut.
- 6. Conduit crossovers are not permitted.

CC. Backbone/Riser conduit entrance in communications rooms – floor entry

- 1. BB/Riser conduits shall enter the communications room floor two inches to four inches on center from the wall and shall stub up six inches AFF.
- 2. Conduit floor stubs shall be spaced in increments to equal the conduit OD from each other.
- 3. BB/Riser conduits shall be installed in a single tier or row from left to right.
 - a. If two tiers or rows are required, the conduits shall be staggered between tiers.
 - b. No more than two tiers or rows are permitted.
- 4. Exiting cable shall be extended to the bottom of the cable tray and be provided with cable support anchors and secured with supporting hardware every six inches above the conduit bushings.
- 5. Conduit floor stubs shall be extended 6" (six inches) from wall on center and 6" (six inches) above AFF.
- 6. The BB/riser cable shall be extended in the cable tray to the terminating equipment, as noted in the Drawings.
- 7. Conduit crossovers are not permitted.

3.03 Cable Tray Installation

- A. Cable tray shall be supported as follows:
 - 1. Where tray is suspended above equipment cabinets, it shall be supported by a Trapeze type hanger and per manufacture instructions. In all other applications, uni-strut trapeze type hangers affixed to the structure above via minimum 3/8" (three-eighths-inch) threaded rod shall support the tray.
 - 2. Threaded rod shall be fitted with a minimum 6" (six-inch) long covering where it resides in cable tray to protect cables.
 - 3. Minimum of 12" (twelve inches) of unobstructed vertical clearance above all cable trays.
 - 4. Minimum of 18" (eighteen inches) of unobstructed horizontal clearance to one side of the cable tray.
- B. Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines.

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- C. Provide sufficient space encompassing cable trays to permit access for installing and maintaining cables.
- D. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2-2006 guidelines, or in accordance with manufacturer's instructions.
- E. A support must be placed within 24 inches on each side of a connection or fitting.
- F. Maintain a minimum of 12 inches of clearance above cable tray for cable installation. Maintain a minimum of 4 inches between ceiling tile and bottom of cable tray support.
- G. Cable tray installation will be completed in one continuous run with no separations between sections.
- H. Vertical cable or ladder racks shall be used to route cable up and down the wall.
- I. Dropout/Water Fall of the same make and size of the cable tray shall be used to route cables in or out of the tray.
- J. Matted "T" and elbows shall be used of the same make and size for all interchanges and directional changes

3.04 JUNCTION BOX/PULL BOX INSTALLATION

- A. Pull boxes shall be installed in sections of conduit that are 100 feet in length, or that contain more than two 90-degree bends.
- B. A pull box shall NOT be used in lieu of a conduit bends.
- C. All pull boxes shall be installed in an easily accessible location with unobstructed entry to the pull box access panel.
- D. Pull boxes 6"x 6" or larger shall be supported on all four corners in such a manner that the cable running through does not support the pull box or conduit attached to the pull box.
- E. All boxes shall be supported with a minimum of two 3/8-inch all-thread.
- F. Boxes shall not be used as supports for conduits. Conduits shall be independently supported within two feet of a pull/junction box. All boxes that are part of a assembly with conduit clips are prohibited.

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3.05 CABLE HOOK INSTALLATION (J-HOOKS)

- A. Cable J-hook systems shall not be used. Exception: J-Hooks are allowed within a tenant lease space only, for horizontal pathways above an enclosed ceiling.

3.06 FIRESTOPPING MATERIAL INSTALLATION

- A. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instruction, and product carton instruction for installation.
- B. Verify substrate conditions are acceptable for product installation in accordance with manufacturer's instructions.
- C. Install fire stopping to comply with performance requirements specified herein.
 - 1. Install fire stopping to comply with listed fire rated assemblies in accordance with ASTM and UL requirements.
 - 2. Installer shall be trained and approved by the manufacturer.
- D. Protect installed products from damage during construction operations until completions.
- E. Inspection: Code official or building inspectors to review proper installation using manufacturer guidelines.

END OF SECTION