SECTION 3 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements as follows:
   1. Pathways for Communications Systems
      a. Conduits and Backboxes
      b. Floor Boxes and Poke Throughs
      c. Cable Trays
      d. Access doors
      e. Fire Stop System Assemblies for Communications Systems
      f. Sleeves entering noise critical spaces
   2. Grounding and Bonding for Communications Systems

1.2 DEFINITIONS

A. Backbone Bonding Conductor (BBC) – The conductor that interconnects elements of the telecommunications grounding infrastructure.

B. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, and potentially other low-voltage systems such as audio-visual, security and fire alarm (electronic safety and security) equipment. Also known as Telecommunications Room, Telecom Room, IT Room, MDF, or IDF.

C. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

D. IDF – Intermediate Distribution Frame, secondary Communications Room(s) for a building

E. IMC – Intermediate Metal Conduit

F. MDF – Main Distribution Frame, the Main Communications Room for a building

G. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications Room (MDF) also acts as the Point of Entrance.

H. Primary Bonding Busbar (PBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

I. RCDD – Registered Communications Distribution Designer as certified by BICSI

J. RMC – Rigid Metal Conduit

K. Secondary Bonding Busbar (SBB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

L. STC – Sound Transmission Class, a single number decibel rating of the transmission loss properties of an assembly. Measured transmission loss data is plotted versus frequency and compared with standard contours according to rules outlined in ASTM E 90 and ASTM E 413.

M. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).

N. Telecommunications Bonding Conductor (TBC) – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

1.3 REFERENCE STANDARDS

A. The references to the following standards and guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON).
   1. TIA-569 – "Telecommunications Pathways and Spaces"
   2. TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
   3. ANSI/NECA/BICSI 607-2011 – Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
   4. BICSI Telecommunications Distribution Methods Manual (TDMM)
   5. [NEMA VE 1 – "Metallic Cable Tray Systems"
   6. NEMA VE 2 – "Cable Tray Installation Guidelines"]
   7. [ASTM E 814 and ANSI/UL1479 –"Fire Tests Through Penetration Firestops"
   8. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"

9. ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”
10. [Telecommunications Service Provider Pathway Requirements

1.4 ADMINISTRATIVE REQUIREMENT

11. Coordinate arrangement, mounting, and support of communications equipment with Telecommunications equipment furnished by Owner and Telecommunications service providers.

A. Coordinate arrangement, mounting, and support of communications equipment:
1. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

1.5 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 26 Section “General Electrical Requirements”:
   a. Product data for the following products:Floor Boxes and Poke Throughs
   b. Cable Trays
   c. Fire Stop Materials and Systems
      1) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
         a) Firestop manufacturer
         b) UL system number
         c) F, T, and L Ratings
         d) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
   d. Telecommunications ground bars and connectors
2. Shop Drawings for:
   a. Submit for review scaled layout drawings showing the routing of all pathways and firestop locations (with quantity and NRTL system number identified), Each pathway shall be identified by type and size on the drawings.
   b. Unless otherwise required by these specifications, it is permissible to show different pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing.
3. Record Documents:
   a. Resubmittal of approved product submittals, with installation and O&M manuals.
   b. Floor plans shall show the routing of all pathways and firestop locations (with quantity and NRTL system number identified) as actually installed. Each pathway shall be identified by type and size on the drawings.
   c. Letter stating that the Telecommunications Grounding and Bonding System has been installed in accordance with the referenced standards and contract documents, including testing requirements.

1.6 NOISE CRITICAL SPACES

A. For Noise –critical spaces, provide Acoustic Pathway Devices as needed and attenuating measures and acoustical sealants as indicated in Division 26, “ Common Work Results for Electrical”.

PART 2 - PRODUCTS AND MATERIALS

2.1 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. Raceways and Boxes for Communications Systems
1. General Requirements
   a. Refer to Division 26, “Raceways and Boxes for Electrical Systems” for Available Manufacturers and other specific product, material and installation requirements.
   b. Outlet boxes located in plenum accessible ceiling space shall be listed for installation in a plenum.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the following paragraphs. Manufacturers and model numbers listed are used only to represent the characteristics required and

are not intended to restrict the use of other Available Manufacturers models that meet the specified criteria.

2. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in stud walls:
   a. Requirements:
      1) Minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth
      2) Provide with a single-gang raised cover/extension ring a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s)
   b. Available Manufacturers:
      1) Emerson/Appleton
      2) Hubbell RACO
      3) Randl
      4) ABB/Thomas & Betts/Steel City
3. Back boxes for Telecommunications Systems (Telephone, Data, and Multi-Service Outlets) installed in masonry construction:
   a. Requirements:
      1) Minimum size shall be double gang, a minimum of 3-1/2 inches deep.
   b. Available Manufacturers:
      1) Emerson/Appleton
      2) Hubbell RACO
      3) Randl
      4) ABB/Thomas & Betts/Steel City
4. Pull Boxes
   a. Refer to Boxes, Enclosures and Cabinets section of Division 26 "Raceways and Boxes for Electrical Systems".

B. Floor Boxes
1. General:
   a. Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
   b. Floor Box Schedule on drawings: Refer to Drawings for specific floor box requirements.Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified in the tables below. Manufacturers and model numbers listed are used only to represent the characteristics required and are not intended to restrict the use of other Manufacturers listed above and models that meet the specified criteria.
   d. UL514A listed for scrub water exclusion for all floor types.
   e. Provide a complete Floor Box Assembly.
   f. Floor boxes used for power: Electrical receptacle(s) shall be provided per Division 26 Section "Wiring Devices" or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
   g. Floor boxes utilized for communications: Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider.

C. Poke-Through Outlets (Multi-Service)
1. General
   a. Basis-of-Design Product: The specified poke-through device is based on the product named. Subject to compliance with requirements; including associated wiring devices, spacing and layout, and other details indicated in contract documents, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
   a. Poke-Through Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
   b. Provide a complete Poke-Through Assembly.
   c. Assembly shall be UL listed and UL Fire Classified, flush type, with one- to four-hour fire rating, as required by floor rating and type.
   d. Poke-through used for power: Electrical receptacle(s) shall be provided per Division 26 Section "Wiring Devices" or as indicated on the Drawings. Refer to Electrical Drawings and Division 26

Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.

e. Poke-through utilized for communications: Include provisions for mounting communications faceplate and connectors in accordance with the requirements of the communications systems provider.

D. Cable Tray

1. Flexible cable tray
   a. Manufacturers:
      1) Atkore/Cope
      2) Bettermann Group/Chalfant
      3) Chatsworth
      4) Eaton/Cooper B-Line
      5) Hubbell
      6) Legrand/Cablofil
      7) MPHusky
      8) nVent/Hoffman
      9) Schneider Electric/WIBE
      10) Thomas & Betts
      11) WBT LLC
   b. Specifications
      1) Cable Tray Size: Size identified on drawings indicate minimum width and depth size.
      2) Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system.
      3) Flexible cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.
      4) Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
      5) Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.
      6) Cable Tray Types:
         a) Wire cable tray:
            i) A cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.
            ii) All 90 degree bends, Tee and Cross intersections shall be long radius transition fittings.

E. Access Doors for Communications Systems

1. Refer to Execution section for location requirements.
2. Refer to Division 26, “Common Work Results for Electrical” for specific product and material information.

F. Fire stop System Assemblies for Communications Systems

1. General
   a. Communications cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple Fire-Rated Pathway Devices for Communications (capacity shall match that of cable tray cross-sectional area), and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.
   b. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer’s instructions.
   c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
2. Fire-Rated Pathway Device for Communications - for sleeves through a single penetration (wall or floor)
   a. Allows the installation and removal of cables without the need to remove or add any materials.
   b. Used to seal penetrations of cables through fire rated partitions.
3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.

   a. Manufacturer shall be:
      1) EZ-Path family of products by Specified Technologies Inc.
      2) cOr equivalent from Conditionally Approved manufacturer.Fire Caulk in a conduit will not be considered equal.

4. Through-Floor Firestopping Sleeve for Communications
    a. Used to seal penetrations of cables through fire rated floor.
    b. Manufacturer shall be:
        1) EZ-Path Series 44 - where (4) sleeves are shown together, provide grid system – STI EZG444
5. Firestopping for Communiccations Backboxes in Fire-Rated Walls
    a. Specifications
        1) Used to seal communications backboxes in fire rated partitions.
        2) Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
        3) Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
    b. Manufacturer shall be:
        1) Specified Technologies Inc., SpecSeal Power Shield
        2) Or equivalent from
            a) 3M
            b) Hilti
6. Firestopping for Thru-Wall (or Floor) Communications Conduit Penetrations and Other Applications
    a. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications required by Communications Pathways not previously addressed in this specification.
    b. Specifications:
        1) Shall be UL listed for the specific application;
        2) Shall meet or exceed the ratings of the wall or floor that it penetrates.
    c. Manufacturer shall be:
        1) Specified Technologies Inc., SpecSeal Power Shield
        2) Or equivalent from
            a) 3M
            b) Hilti

G. Sleeves Entering Noise Critical Spaces – Acoustic Pathway Device

1. Where walls or ceiling-mounted Communications Devices are located inside Noise Critical Spaces, and/or for Communications System sleeves through acoustically-rated (non-fire-rated) walls at or above STC-50, provide Acoustic Pathway Device(s) to support low-voltage telecommunications/AV/security cabling.
2. Specifications:
    a. Shall maintain STC Rating of the penetrated wall.
    b. Shall accommodate cable loads from 0 to 100% visual fill.
    c. Shall be zero-maintenance, meaning no action is required by cabling technician to open/close pathway for cable moves, adds, or changes.
    d. Shall be engineered such that cables can be removed or added
    e. Where more than one Acoustic Pathway Device is needed, they shall be ganged together with manufacturer supplied grid.
    f. For use in non-rated walls only.
    g. For use in place of conduit sleeves through walls of noise critical spaces.
    h. Plenum Rated (to UL2043)

3. Manufacturer shall be:
    a. Hilti CS-SL SA
    b. Specified Technologies, Inc. - NEZ33

2.2 BONDING AND GROUNDING (EARTHING)

A. General

1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard "Generic Telecommunications Bonding and Grounding for Customer Premises". Major components include:
    a. PBB in the Entrance Facility and SBBs in all remaining Telecommunication Rooms and Spaces.
    b. TBC connecting the PBB to the main Electrical Service Ground.
    c. TBB connecting the PBB to all SBBs.
    d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.

2. Available Component Manufacturer[s]:
    a. Chatsworth
    b. Cooper B-Line
    c. Erico
    d. Harger
    e. Hoffman
    f. Panduit
3. Conductor Manufacturers
    a. Shall be from the list of Component Manufacturers; or
    b. Shall be from the list of Manufacturers in Division 26 Section “Low-Voltage Electrical Power Conductors and Cables”.

B. Primary Bonding Busbar (PBB)
1. Specifications
    a. All busbars shall have a clear cover installed to protect connections
    b. Cover shall be:
        1) Plexiglass or plastic
        2) Cover shall be printed with 3/8” lettering “PBB” using appropriate labels.
        3) Of the same manufacturer as the ground bar
    c. A predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
    d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
    e. Provide enough length for all connections with 25% growth.
    f. Provided with insulators to electrically isolate busbar from mounting surface.
    g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
2. Manufacturer shall be
    a. Harger TGBIP14420TMGB
    b. Chatsworth 40153-020
    c. Or equivalent from Component Manufacturer

C. Secondary Bonding Busbar (SBB)
1. Specifications
    a. Be a predrilled Electrotin plated copper busbar provided with holes for use with standard sized lugs
    b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
    c. Provided with insulators to electrically isolate busbar from mounting surface
    d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
2. Manufacturer shall be
    a. Harger TGBI14212TGB
    b. Chatsworth # 13622-012
    c. Or equivalent from Component Manufacturer

D. Ground Wire for TBB
1. Specifications
    a. All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.
    b. All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
    c. Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
    d. Cable jacket marking: Shall be legible and shall contain the following information:
        1) Manufacturer’s name.
        2) Copper Conductor Gauge.
        3) UL listing.
    e. Cable jacket shall be green with black lettering.
    f. Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.

E. Bonding Conductor (To main Electrical service ground) for Telecommunications (TBC): Insulated grounding wire with a minimum copper conductor size equal to that of the TBB, with PVC insulation. Shall be UL listed.
1. Specifications
    a. Copper.
    b. Insulated grounding wire with PVC insulation
    c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the PBB, UON.
    d. Cable jacket marking: Shall be legible and shall contain the following information:
        1) Manufacturer’s name

2) Copper Conductor Gauge
3) NRTL listing information
e. Cable jacket shall be green with black lettering
f. A minimum conductor size as indicated on drawings

F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)
1. Specifications
a. Copper.
b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
d. Cable jacket marking: Shall be legible and shall contain the following information:
1) Manufacturer's name.
2) Copper Conductor Gauge.
3) UL listing.
e. Cable jacket shall be green with black lettering.

G. Connectors / Connections
1. Specifications
a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.
2. Compression Lugs
a. Specifications
1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
2) Shall include inspection port.
3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)
b. Manufacturer shall be:
1) Harger GECLB Series
2) Or Approved Equivalent
3. Conductor to conductor connection
a. Specifications
1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.
b. Manufacturer – Exothermic Weld
1) Erico CADWELD
2) Harger Ultraweld
3) Or Approved Equivalent
c. Manufacturer – Irreversible Compression connector
1) Burndy HYGROUND
2) Or Approved Equivalent
4. Connector for conduit to cable
a. Specifications
1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the PBB/SBB.
b. Manufacturer shall be:
1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe lamp
2) For less than 1" diameter conduits – Harger TBGC4SCS elctro tin-plated conduit bonding clamps
3) Or Approved Equivalent
5. Connector for conductor to cable tray
a. Specifications
1) For metallic cable trays that extend to the Telecommunications Room.
b. Manufacturer shall be:
1) Harger electro tin-plated cable tray bonding clamps – TBCTC
2) Or Approved Equivalent

H. Insulated Grounding Bushings
1. Specifications
a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
b. Shall be UL Listed for copper conductors.
c. Shall include lug for easy connection of conductor to PBB/SBB.

2. Manufacturer shall be:
   a. O-Z/Gedney IBC-L
   b. Or Approved Equivalent

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

A. General
   1. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
   2. Permanently mark or tag each raceway at intervals of not more than 75 feet (22.86 m), and each junction box and pull box. Permanently mark or tag each raceway that is stubbed into the ceiling space from an outlet box. Identifying them as "TELECOM" or "AV" as appropriate.
   3. Coordinate the following with cable-installing contractor.
      a. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
      b. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
      c. Provide all communications pathways:
         1) So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
         2) So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
         3) So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines
         4) So that the maximum allowable pulling tension is not exceeded
         5) To meet the requirements of the structure and the requirements of all other Work on the Project.
         6) Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Contract Administrator.
         7) Parallel or perpendicular to building lines or column lines.
         8) When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
      d. Follow manufacturer's recommendations for allowable fill capacity. Do not exceed load ratings specified by manufacturer.
   4. Access to pathways and associated equipment
      a. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
      b. Provide an access door where equipment or devices are located above inaccessible ceilings.
      c. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
      d. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

B. Conduits and Backboxes for Communications
   1. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and owner Standards (if applicable).
   2. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
   3. Conduits which enter telecommunications rooms shall extend 1 inch (25.4 mm) to 3 inches (76.2 mm) AFF.
   4. Flexible conduits may only be used where specifically allowed by these contract documents.
      a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length and shall be increased by (1) trade size
   5. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
   6. Conduit runs shall not exceed a total of 150-feet (45.7 m).

7. No more than (2) 90° bends, or equivalent will be allowed between pullboxes.
   a. Each and any offset shall be considered a 90° bend.
   b. A pullbox is required wherever a reverse bend is installed.
8. The minimum bend radius for conduits is
   a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.
   b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).
9. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
10. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Rated partitions shall be provided with appropriately rated firestop systems. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
11. Pull Boxes
    a. Pullboxes shall be placed in Conveniently Accessible locations.
    b. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
    c. Pullboxes above an accessible ceiling shall:
       1) Be aligned directly over the ceiling grid to allow access
       2) Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
    d. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
    e. Size pullboxes according to the following chart:

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
¾" or smaller	4"	4"	2-1/8"	Not applicable
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

12. Provide an empty EMT raceway from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, install raceways to the nearest accessible corridor ceiling or as indicated on the Drawings.
13. No outlet boxes shall be located back-to-back in a wall cavity.
    a. Where possible offset to next stud cavity, but no less than a 6 inches (152.4 mm) separation.
14. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
15. Provide conduit as indicated on the Drawings or required by this Specification. Minimum communications conduit size shall be 1 inch (25.4 mm). Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as Communications, at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged.

C. Cable Tray

1. Cable trays shall be installed in accordance with manufacturer installation instructions, applicable electrical code, and standards. Comply with recommendations in NEMA VE 2.
2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.
3. Fasten cable tray supports to building structure
4. Place supports so that spans do not exceed maximum spans on schedules.
5. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
6. Support bus assembly to prevent twisting from eccentric loading.
7. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3.
8. Locate and install supports according to NEMA VE 1.

9. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
10. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

D. Fire stop System Assemblies for Communications Systems
1. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
2. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by approved NRTL by the AHJ and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
3. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes and National Electric Code.
4. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
   a. Fire stop Manufacturer
   b. Installer and company
   c. Date installed
   d. UL system number with all relevant ratings indicated

3.3 TELECOMMUNICATIONS BACKBOARD

A. Mount Telecommunications Ground Bars (PBB and SBBs) to telecommunications backboard.

3.4 GROUNDING AND BONDING INSTALLATION

A. General:
1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. “Daisy chaining” of Telecommunications ground bus bars back to the PBB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a “coupled bonding conductor” effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Telecommunications Bonding Conductor (TBC), each Telecommunications bonding backbone (TBB) conductor, and each Backbone bonding conductor (BBC shall be green or marked with a distinctive green color.
   a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods.
   b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
   c. Follow additional installation requirements from NECA/BICSI 607-2011 “Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings”.

B. Required Grounding Connections:
1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the SBB in the room. Each conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.

2. Provide and install one individual ground wire from the raised floor system (if applicable) to the PBB. Conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.
3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the SBB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:
1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer’s instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:
1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.

IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER

E. Quantities of Ground Wires (Conductors)
1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)
1. Subject to the applicable electrical code and the reference standards and guidelines, the TBC, TBB, BBC conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

LINEAR LENGTH (FT)	AWG SIZE
LESS THAN 13	6
14-20	4
21-26	3
27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 KCMIL
126-150	300 KCMIL
151-175	350 KCMIL
176-250	500 KCMIL
251-300	600 KCMIL
GREATER THAN 301	750 KCMIL

G. Testing
   1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
   2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
   3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
      a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance
   1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings
   1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.