# SECTION 26 05 26

*~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~*
*ARCHITECT OF RECORD/ENGINEER OF RECORD IS RESPONSIBLE FOR REVIEWING THIS SPECIFICATION SECTION IN DETAIL FOR COORDINATION WITH THE PROJECT SCOPE OF WORK.*

*ALL "PROJECT NOTE" TEXT IS TO BE REMOVED FOLLOWING REVIEW OF THE CONTENT OF EACH NOTE BY THE ARCHITECT OF RECORD/ENGINEER OF RECORD.*

*EDIT THE DOCUMENT FOOTER TO INCLUDE THE PROJECT NAME AND NUMBER.*

*EDIT THE DOCUMENT HEADER TO INDICATE THE ARCHITECT OF RECORD PROJECT ISSUE" DATE. THE "CPS CONTROL" DATE SHOULD NOT BE EDITED.*

*ANY MODIFICATIONS TO THE TECHNICAL STANDARDS IN THIS SECTION - INCLUDING THE REMOVAL OR ADDITION OF MANUFACTURERS - MUST BE APPROVED BY CPS.*

*REQUESTS FOR MODIFICATION ARE TO BE SUBMITTED TO THE DESIGN MANAGER DURING THE DESIGN PHASE FOR REVIEW AND APPROVAL.*
*~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~*

## GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

PART 2 -
*~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~*
*SELECT GROUNDING SYSTEM COMPONENTS TO BE INCLUDED IN SCOPE OF WORK.*
*~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~*

2.01 SECTION INCLUDES

A. Grounding and bonding requirements.
   1. Equipment grounding.
   2. Wiring device grounding.
   3. Panelboard grounding.
   4. Switchboard grounding.
   5. Isolated grounding.
   6. Telecommunication Grounding (TGB) including:
      a. Telecommunications Main Grounding Busbar (TMGB).
      b. Telecommunications Grounding Busbar (TGB).
      c. Telecommunications Bonding Backbone (TBB).

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

D.
*~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~*
*TGB, TMGB AND TBB GROUNDING BARS TO BE INCLUDED IF REQUIRED UNDER PROJECT. COORDINATE WITH TELECOMMUNICATIONS SPECIFICATIONS.*

*~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~*

E. Ground bars.

F. Ground rod electrodes.

G. Ground loop.

2.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.

B. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

C. Chicago Electrical Code - Municipal Code of the City of Chicago, Building/Electrical Code Requirements; 2018.

D. IEEE 1100 - IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment; 2005.

E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.

H. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.

I. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; Rev C, 2015.

J. TIA-942 - Telecommunications Infrastructure Standard for Data Centers; 2017.

K. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

L. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.

2.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. Verify exact locations of underground metal water service pipe entrances to building.
2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
3. Notify Architect/Engineer of Record of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

2.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of component for grounding and bonding system(s).

C. Shop Drawings:
   1. Plans showing dimension as-built locations of grounding features, including the following:
      a. Ground rods.
      b. Grounding arrangements and connections for separately derived systems.
      c. Grounding for sensitive electronic equipment.
   2. Grounding rod and ground loop locations.
   3. Grounding arrangements and connections for separately derived systems.
   4. Grounding for sensitive electronic equipment.

D. Field quality control test reports with indication of overall resistance to ground.

E. Project Record Documents: Record actual locations of grounding electrode system components and connections.

F. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
      a. Periodic testing and inspection shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

2.05 QUALITY ASSURANCE

A. Product Listing Organization Qualifications: An organization recognized by OSHA regulation 1910.7 as a Nationally Recognized Testing Laboratory (NRTL) and as defined in the City of Chicago Electrical Code, Article 100.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Conform with UL 467 for grounding and bonding materials and equipment

D. Conform with City of Chicago Electrical Code.

E. Installer Qualifications: Electrical contractor approved by the Board for installation and termination of the main bonding conductor to the building service entrance ground.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

G. Follow IEEE 1100 - Recommend Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book).

## PART 3 - PRODUCTS

3.01 GROUNDING AND BONDING REQUIREMENTS

**3.02**

***~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~***
***REMOVE EXISTING WORK FOR PROJECTS THAT ARE NEW OR DO NOT MODIFY EXISTING GROUNDING SYSTEMS.***

***~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~***

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by the City of Chicago Electrical Code and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with the City of Chicago Electrical Code but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect/Engineer of Record. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not to exceed the values set forth to ground as indicated in part 3.03 of this specification, when tested according to IEEE 81 using the "fall-of-potential" method.
   3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

F. Grounding Electrode System:
   1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
      a. Provide continuous grounding electrode conductors without splice or joint.
      b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
   2. Metal Underground Water Pipe(s):
      a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
      b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
      c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
   3. Metal In-Ground Support Structure:
      a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with the City of Chicago Electrical Code.
   4. Ground Ring:
      a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
      b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
      c. Provide connection from ground ring conductor to:
         1) Perimeter columns of metal building frame.
         2) Ground rod electrodes located as indicated.
   5. Ground Rod Electrode(s):

a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
b. Space electrodes not less than 10 feet from each other and any other ground electrode.

6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in the City of Chicago Electrical Code. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
   a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
   b. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
8. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in the City of Chicago Electrical Code.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
   a. Transformers (except autotransformers such as buck-boost transformers).
   b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
   c. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with the City of Chicago Electrical Code.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with the City of Chicago Electrical Code.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with the City of Chicago Electrical Code.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with the City of Chicago Electrical Code. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
   b. Metal gas piping.
   c. Metal process piping.
8. Provide bonding for interior metal air ducts.
9. Provide bonding for metal building frame.
10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with the City of Chicago Electrical Code.
12. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

K. Isolated Ground System:
1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated equipment grounding conductors.
2. Connect isolated equipment grounding conductors only to separate isolated equipment ground busses.
3. Connect the isolated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.
4.

***~~~ PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~***
***PROVIDE PROJECT SPECIFIC CRITERIA AND DEVICES FOR GROUNDING SYSTEM IN RELATION TO THE TELECOMMUNICATIONS SCOPE OF WORK. COORDINATE WITH TELECOMMUNICATIONS SPECIFICATIONS.***

***~~~ END OF PROJECT NOTE ~~~~~~~~~~~~~~~~~~~~~~~~~***

L. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with the City of Chicago Electrical Code.

2. Communications grounding system shall adhere to the recommendations of the TIA-942 and TIA-607-C standards, and shall be installed in accordance with best industry practices.
3. Utilize equipment manufacturer bonding terminals where provided.
4. Thread-forming screws and paint piercing grounding washers will be used to ensure metal-to-metal contact.
5. In MDF/IDF telecommunication rooms mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGESD-1 (or OTS approved equal), directly to each side of the vertical mounting rail of the center most rack using thread-forming screws to form a bond to the rack. Mount at approximately 48 inches from the floor. Place the Electric Static Discharge (ESD) protection identification stickers directly above the ESD ports.
6. Provide an equipment grounding conductor from the Telecommunications Grounding Busbar (TGB) to each MDF/IDF rack grounding bar and ladder tray.
7. Each Concentrator Enclosure Telecommunications Grounding Busbar (TGB) will:
    a. Be terminated to the equipment ground terminal within the isolated ground receptacle outlet box.
    b. Have a ground conductor to the enclosure door.
8. Two-hole lugs shall be used to resist loosening. All lugs shall be irreversible compression type.
9. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
    a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
    b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
    c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
10. Grounding/Earthing System (in reference to Telecommunication Systems)
    a. Antioxidant shall be used when making bonding connections in the field.
    b. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded (earthed) to the Telecommunications Main Grounding Busbar (TMGB) located at the electrical service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) shall follow TIA-607-C and referenced in the table appendix for sizing the Telecommunications Bonding Backbone (TBB).
    c. The Telecommunications Main Grounding Busbar (TMGB) shall be bonded to the electrical service grounding according to the BICSI TDMM rev. 10 and TIA-607-C. Verify all requirements in Chicago Electrical Code (including all updates and addendum) as they may supersede the BICSI requirements. Where telecommunications spaces have only one rack, the jumper cables must be connected directly to the Telecommunications Grounding Busbar (TGB).
    d. Route the TBB to each TGB in straight pathways. The TBB shall be a continuous conductor. The TBB shall be bonded to the equipment ground bar in the IG Computer Panel to the TGB in the MDF and IDF's.
    e. In the event of more than one TBB, the contractor will bond them together at the TBD on the top floor with a Grounding Equalizer (GE). Reference the TIA-607-C standards for sizing TBB's for the GE.
    f. Building steel and metallic water piping must be bonded to the grounding system for safety, however neither may be utilized as the TBB.
    g. Equipment racks shall be bonded to the grounding system in accordance with TIA-942.
    h. To maintain continuity throughout each equipment rack where bonding to the grounding system paint or insulators must be ground away to expose bare, unpainted, and uncoated metal to insure metal to metal contact.
    i. Paint piercing grounding washers and hardware shall be used where rack sections join together. Paint piercing hardware will be used on both sides when and where the hardware passes through the rack.

j. Any metallic components that part of the data equipment (equipment, racks, ladder racks, enclosures, cable runway, etc.) must be bonded to the grounding systems.

11. Each of the Communications surge protection devices shall be grounded in accordance with manufacturers recommendations as presented in product installation instructions to the TGB.

M. Lightning Protection Systems, in Addition to Requirements of Section[]26 41 13 - Lightning Protection for Structures:
1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with the City of Chicago Electrical Code, NFPA 780 and UL 96.

3.03 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26 - Grounding and Bonding for Electrical Systems.
1. Use insulated copper conductors unless otherwise indicated.
a. Exceptions:
1) Use bare copper conductors where installed underground in direct contact with earth.
2) Use bare copper conductors where directly encased in concrete (not in raceway).
2. Equipment Grounding Conductors: Insulated with green color insulation.
3. Grounding-Electrode Conductors: Stranded cable.
4. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
5. Insulated Conductors: Wire or cable insulated for 600V unless otherwise required by applicable code or authorities having jurisdiction.
6. Bare Copper Conductors:
a. Solid Conductors: ASTM B3.
b. Stranded Conductors: ASTM 8.
c. Tinned Conductors: ASTM B33.
d. Bonding Cable: 28kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
e. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
f. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
g. Bonding Straps: Soft copper, 0.05 inch think and 2 inches wide, except as indicated.
h. Cable assemblies shall be UL listed and CSA certified.
i. Cables shall be a distinctive green (equipment ground) or green/yellow tracer (isolated ground ) in color, and all jackets shall be UL, VW-1 flame rated.

C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors or exothermic welded connections for accessible connections.

4. Mechanical Connectors: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   a. Heavy Duty Pipe Clamps: Pipe clamps shall be high copper alloy or cast bronze with silicon bronze threaded fasteners; saddle type designed for the size of conductor indicated or required by Contract Documents.
   b. Beam Clamps: Beam clamps shall be compression type; heavy duty bronze construction; provide a minimum of 8 square inches of bonding surface; and designed for copper rope-lay cable.
   c. Grounding Bushing: Groundings bushings shall be malleable iron, threaded, with insulated liner and solderless lug.
5. Pressure Connectors: High-conductivity plated units.
6. Terminating Lugs: Exothermic weld or crimp compression type.
7. Manufacturers - Mechanical and Compression Connectors:
   a. Burndy LLC: www.burndy.com.
   b. Harger Lightning & Grounding: www.harger.com.
   c. Thomas & Betts Corporation: www.tnb.com.
   d. NSI Industries; www.nsiindustries.com.
8. Manufacturers - Exothermic Welded Connections:
   a. Burndy LLC: www.burndy.com.
   b. Cadweld, a brand of Erico International Corporation: www.erico.com.
   c. Cadweld, a brand of Erico International Corporation; www.erico.com.

D. Ground Bars:
1. Description: Rectangular bars of annealed copper, 1/4 by 2 inches in cross-section, unless otherwise indicated; with insulators.
2. Length: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.

E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
   a. Harger Lightning & Grounding: www.harger.com.
   b. Burndy LLC; www.burndy.com
   c. NSI Industries; www.nsiindustries.com
   d. Thomas and Betts Corporation; www.tnb.com

F. Ground Ring:
1. Material: Copper
2. Size: As indicated.
3. Manufacturers: Refer to "Grounding and Bonding Requirements".

## PART 4 - EXECUTION

4.01 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.

B. Verify that conditions are satisfactory for installation prior to starting work.

4.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions and the City of Chicago Electrical Code.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, provide ground plates.
   1. Outdoor and Indoor Installations: Unless otherwise indicated, install with top of rod 2 inches below finished grade.
      a. Verify all conditions prior to initiation of work.
      b. Verify final backfill and compaction are complete before driving rod electrodes.
      c. Do not expose steel or damage coating, if any, on interconnection of ground rods with grounding electrode conductors
      d. Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to service grounding electrode conductor.

E. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Bond straps directory to structure without penetrating adjacent parts.
   4. Install bonding to equipment mounted on vibration isolators so any vibration from equipment is not transmitted to any other equipment, devices, fixtures, and/or structure.
   5. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
   8. Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building.
      a. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange.
      b. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting.
      c. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   9. Use braided-type bonding jumpers at water meter piping to electrically bypass water meters. Connect to pipe with a bolted connector.
   10. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Identify grounding and bonding system components in accordance with Section[]26 05 53 - Identification for Electrical Systems.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connector for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

H. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

4.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Restore surface features, including vegetation, at areas disturbed by work of this Section including but not limited to:
1. Re-establish original grades, except as otherwise indicated.
2. Where sod has been removed, replace it as soon as possible after backfilling has been completed.
3. Restore areas disturbed by trenching of dirt, cable laying, and other activities to their original condition.
   a. Include trenching, storing of dirt, cable laying, and other areas to their original condition.
   b. Include top soiling, fertilizing, liming, sodding, sprigging, and mulching.
4. Restore disturbed paving as indicated or to original condition prior to the initiation of work of this Section.

C. Perform the following tests and inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells and at individual ground rods. make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   c. Perform tests by fall-of-potential method according to IEEE 81.

D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements or exceed the following values:
1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10ohms.
2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
4. Substations and Pad-Mounted Equipment: 5 ohms.

E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

F. If resistance to exceeds specified values, notify Architect/Engineer of Record immediately with inclusion of recommendations to reduce ground resistance.

**END OF SECTION 26 05 26**