PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and the following specification sections apply to all Work herein:
   1. Section 26 00 10 - General Requirements
   2. Section 26 00 20 - Scope of Work
   3. Section 26 05 19 - Electrical Conductors - 600 Volts
   4. Section 26 05 33 - Raceways and Boxes
   5. Section 26 08 13 - Testing

1.2 SUMMARY

A. Furnish and install electrical grounding and bonding systems as indicated on the Drawings and as specified herein.

1.3 REFERENCE STANDARDS

A. All grounding and bonding system components shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:
   1. UL Standard 467 - Electrical Grounding and Bonding Equipment
   2. NFPA 70 - National Electrical Code (NEC)

B. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the authorities having jurisdiction, and suitable for its intended use on this Project.

1.4 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and Section 26 00 10 and shall include, but not be limited to:
   1. Products and materials complete with material list, ground rods, flexible bond jumpers, test wells, connectors, ground bars, insulators, etc.
   2. Proposed test procedures, recording forms, test equipment, and list of personnel and qualifications for all tests proposed. Refer to Section 26 08 13 titled “Testing” for additional requirements.
   3. Field Test Reports:
      a. Ground Rod Ground Resistance Test.
      b. Two Point Ground Resistance Test.
      c. Ground Termination Resistance Tests.

B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification “MCA” as set forth in Section 26 00 10. See Section 26 00 10 for certification requirements.

1.5 WARRANTY

A. Comply with the requirements of the General Conditions and Section 26 00 10.

PART 2 PRODUCTS

2.1 GENERAL

A. All equipment and materials provided under this section of the Specifications shall be new, UL listed and bear the UL label.

B. All switchboards, panelboards, transformers, busway, etc. shall be provided with a copper equipment ground bar bolted, brazed or riveted to the associated enclosure or cabinet. Refer to each individual equipment Specification section for additional grounding requirements.

C. All receptacles, switches, disconnects, individual motor controllers, etc. shall be provided with a grounding terminal connected to the device frame or enclosure. Refer to each individual equipment Specification section for additional grounding requirements.

D. All conduit, cable tray, manufactured wiring systems, raceways, junction boxes, pull boxes, etc., shall be made electrically continuous by means of grounding conductors, bonding jumpers, grounding bushings, etc., as required by the NEC and the authorities having jurisdiction.

2.2 GROUNDING CONDUCTORS

A. All grounding electrode conductors shall be bare or green insulated copper conductors sized as indicated on the Drawings. Where the Authorities having jurisdiction requires grounding electrode conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.

B. All equipment grounding conductors shall be green insulated copper conductors sized as indicated on the Drawings. Where the Authorities having jurisdiction requires equipment grounding conductor sizing in excess of that shown on the Drawings or specified herein, the larger size conductor shall be installed.

C. All bonding conductors shall be flexible copper bonding jumpers sized in accordance with the NEC for grounding electrode conductors.

2.3 GROUND RODS

A. All ground rods shall be a minimum of 3/4" x 10'-0" copper clad steel unless otherwise indicated on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

A. The system neutral shall be grounded at the service entrance. The system neutral on interior wiring shall be kept isolated from grounding systems throughout the building and shall be grounded only to the grounding electrode conductor.

B. Each system of electrically continuous metallic piping and ductwork shall be electrically grounded in accordance with the requirements of the NEC for “bonding” as they apply to the “bonding of piping systems”. Isolated metallic piping and duct systems shall be bonded to the building equipment grounding system.

C. Bonding and grounding conductors shall be sized, shall be run in conduit except where otherwise indicated and shall be connected to various services in accordance with the requirements of the authorities having jurisdiction and the National Electrical Code.

D. Grounding shall be done in accordance with the requirements of and subject to the approval of the Architect, Engineer and local inspection authorities. Approved materials, devices and Workmanship shall be utilized. All conductor terminations shall be in accordance with Section 26 05 19 titled “Electrical Conductors – 600 Volts”.

E. Grounding Electrode System:
   1. The grounding electrode conductor shall be bonded together with the incoming domestic water metallic piping system to the building (where galvanized piping is used in direct contact with the earth), the metal frame of the building, the concrete encased steel reinforcing bars in or near the building footings and a ground ring encircling the building, as indicated on the Drawings. This bonding shall serve as the grounding electrode system in accordance with the requirements of the NEC. The Electrical Subcontractor shall not connect any bonding jumpers to water piping systems throughout the building except at one point.

2. The grounding electrode conductor shall be installed in a separate conduit from the point of connection at the grounding electrode system to the system neutral in the main switchboard(s). The grounding electrode conductor shall be insulated stranded copper, sized as required and/or as indicated on the Drawings and shall be without joints or splices over its entire length.

F. Building Equipment Ground:
1. The building equipment grounding system shall consist of the electrically continuous metallic conduit system together with equipment ground conductors extended from the main service as indicated. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems which are isolated by flexible connections, insulating couplings, etc. shall be bonded to the equipment ground with a flexible bonding jumper.

G. Ground Ring:
1. A bare copper conductor encircling the structure shall be installed in direct contact with the earth at a depth below earth surface not less than 2'-6", sizes as required and as indicated on the Drawings. The loop thus formed shall be bonded together with the incoming cold water metallic piping system, ground rods, the metal frame of the building and the concrete encased steel reinforcing bars in the building footings as described in the Subsection entitled “Grounding Electrode System” hereinbefore.
2. The bonding conductors shall be bare copper, size as indicated on the Drawings or larger if required by Code. Joints and splices shall be made only where connections are made to the ground ring and shall be of the exothermic weld type.
3. Test wells shall be provided at no less than two locations where indicated on the Drawings to allow inspection and testing of the ground ring continuity. Locate test wells in accessible locations where approved by the Architect.

H. Flexible Bonds:
1. All expansion joints, points of electrical discontinuity or connections in conduit where firm mechanical bond is not possible shall be bonded with OZ Gedney Type “BJ” or approved equal bonding jumper.
2. A flexible bonding jumper shall be provided around isolating couplings and isolating nipples and shall be similar and approved equal to OZ Gedney Type “BJ”. All mechanical piping requires isolating couplings or isolating nipples when the piping material is changed.
3. Mechanical equipment shall be bonded electrically to the building equipment grounding system. This includes but is not limited to flexible duct connections, air handling units, fans, pumps, etc. All connections made to the ground ring within test wells shall be “reversible” type connections to allow testing and inspection of ground ring.

I. Separately Derived System Grounding:
1. Separately derived systems shall consist of a grounding electrode conductor, sized as required or as indicated on the Drawings, connected to the Building Steel as indicated on the Drawings.

J. Telecommunication System Ground Riser:
1. Provide a telecommunication grounding riser with a tapped bar on each floor as detailed on the Drawings. Grounding riser shall be connected to the grounding electrode conductor as indicated on the Drawings.

3.2 GROUNDING SYSTEM TESTING

A. Three Point Fall of Potential Ground Rod Ground Resistance Test:
1. Each ground rod must be exposed and accessible to conduct this test. Ground rods shall not be connected to the grounding electrode system when conducting the test.
2. Conduct ground resistance test at each ground rod using the three point fall of potential test.
3. Measure and record ground resistance of each ground rod including but not limited to all ground rods connected to the ground ring, lightning protection ground rods, and the ground rod within each test well.
4. Ground resistance at each ground rod shall not exceed 5 ohms. Where ground resistance at the ground rod is measured to be more than 5 ohms provide additional grounding to achieve required results.
5. The field test results shall be submitted by the Subcontractor for review. Field test reports shall include, but not be limited to:
   a. Test performed.
   b. Test procedure.

c. Ground rod location and connection point to the system (nearest column, etc.) (connected to ground ring, connected to lightning protection, etc.).
d. Date(s) and time(s) of test.
e. Weather conditions including temperature and relative humidity.
f. Final test values.
g. Additional pertinent data.
h. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
i. Personnel printed name, title, company, and signature of persons who performed the test.

B. Two Point Ground Resistance Test:
1. Tests shall be performed with low-resistance ohmmeter to measure resistance of each grounding electrode conductor and systems listed hereinafter. The conductor terminations shall be included between the two points of the test.
2. Any conductor which is found to have measurements that are excessive the conductor shall be investigated and corrected and additional tests shall be performed.
3. The test shall include but is not limited to grounding electrode conductors between the following locations:
   a. The ground ring to the main electrical ground bar.
   b. The ground ring to the main telecom ground bar.
   c. The main electrical room ground bar to the main telecom ground bar.
   d. Each main ground bar to both electrical and telecom ground riser locations.
   e. The main ground bar to the incoming cold water metallic piping.
   f. Each service entrance switchboard to the main electrical ground bar.
   g. The main ground bar to connection to building steel.
   h. Each separately derived system to the connection to the building electrical ground riser or building steel.
4. Ground Ring: In addition to the locations listed above, continuity of the ground ring shall be tested by disconnecting the ground ring at the test well and measuring resistance between each end of each ground ring segment.
5. The field test results shall be submitted by the Subcontractor for review. Field test reports shall include, but not be limited to:
   a. Test performed.
   b. Test procedure.
   c. Conductor section tested and conductor description (Manufacturer, size, type, rating, location, etc.).
   d. Identify of the two end points for the test.
   e. Date(s) and time(s) of test.
   f. Weather conditions including temperature and relative humidity.
   g. Test criteria.
   h. Test results.
   i. Additional pertinent data.
   j. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
   k. Personnel printed name, title, company, and signature of persons who performed the test.

C. Ground Termination Resistance Test:
1. Tests shall be performed with low-resistance ohmmeter to measure resistance of all bolted ground terminations. This test shall include neutral-ground system grounding electrode conductor terminations for separately derived systems after final terminations are made (after Neutral-Ground Isolation Test as described in Section 26 08 13). Compare resistance measurements between like terminals. Where resistance is measured to be 50% or more above the lowest terminal reading, adjust, or replace termination until resistance is within 50% of lowest reading. For compression connectors, the resistance measurement shall include both the compression connection and the bolted termination.
2. The Electrical Contractor shall record and tabulate readings observed at grounding electrode conductor terminations in each of the following locations:
   a. All ground bar(s) in electrical equipment rooms or spaces.
   b. All ground bar(s) in telecommunications rooms or spaces.
   c. Ground terminations at equipment/system that is directly connected to these ground bars.
3. The field test results shall be submitted by the Subcontractor for review. Field test reports shall include, but not be limited to:
   a. Test performed.

b. Test procedure.
c. Conductor section tested and conductor description (Manufacturer, size, type, rating, location, etc.).
d. Termination Type (ie: two (2) hole compression connector; bus connection).
e. Date(s) and time(s) of test.
f. Weather conditions including temperature and relative humidity.
g. Test criteria.
h. Test results.
i. Percent variation above the lowest reading of like terminal (shall not exceed 50% above lowest terminal reading).
j. Additional pertinent data.
k. Instruments including documentation that such instruments were properly calibrated at the time of the testing.
l. Personnel printed name, title, company, and signature of persons who performed the test.

D. Refer to Section 26 08 13 titled “Testing” for additional requirements for grounding system testing.

END OF SECTION