SECTION 16170 - GROUNDING SYSTEM

City of San Diego, CWP Guidelines

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

A. The WORK of this Section includes providing grounding for electrical systems, exposed nonenergized metal surfaces of equipment and metal structures.

1.2 RELATED SECTIONS

A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK.

1. Section 03300 Cast-In-Place Concrete
2. Section 05120 Structural Steel
3. Section 05500 Miscellaneous Metalwork
4. Section 16050 Basic Electrical Materials and Methods

1.3 CODES

A. The WORK of this Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:

1. National Electrical Code

1.4 SPECIFICATIONS AND STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

1.	IEEE 81	Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, Guide for
2	UL 467	Standard for Grounding and Bonding Equipment

1.5 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01300:

1. Shop drawings showing details of grounding system.
2. Product data for grounding electrodes and connections.

1.6 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Manufacturer's instructions including instructions for storage, handing, protection, examination, preparation and installation of exothermic welded connectors.

2. Test reports indicating overall resistance to ground [and resistance of each electrode].

1.7 PROJECT RECORD DRAWINGS

A. The following shall be included in the PROJECT RECORD DRAWINGS in compliance with Section 01300:

1. Accurate record of actual locations of grounding electrodes.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. **Delivery of Materials:** Products shall be delivered in original, unbroken packages, containers, or bundles bearing the name of the manufacturer.

B. **Storage:** Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The WORK of this Section includes the following:

1. Products listed and classified by [Underwriters Laboratories, Inc.] [testing firm acceptable to authority having jurisdiction] as suitable for purpose specified and shown.

2. Except as otherwise indicated, grounding products and systems shall comply with the NEC.

2.2 ROD ELECTRODE

A. Rod electrodes shall be [3/4] [ ] inch copper-clad steel, sectional type, joined by threaded copper alloy couplings. Length of rods forming an individual ground array shall be equal in length and shall be of the length required to obtain a minimum ground resistance of [5] [ ] ohms. Top of ground rod shall be fitted with a coupling and steel driving stud. Rods shall be of sufficient length to ensure contact with ground water and shall be not less than [ ] [5] [8] [10] feet.

2.3 CABLE

A. Ground cable shall be annealed bare copper, concentric stranded wire. If cable sizes are not indicated, the minimum sizes shall be as follows:

1.	5 and 15 kV switchgear	4/0 AWG
2.	5 kV motor starters	4/0 AWG
3.	15 kV-5 kV transformers	4/0 AWG
4.	5 kV-480V transformers	4/0 AWG
5.	480V switchgear	4/0 AWG
6.	480V MCC and switchboards	2/0 AWG
7.	Cable tray	2/0 AWG
8.	Lighting panels	2 AWG

9. Exposed metal 2 AWG

2.4 MECHANICAL CONNECTORS

A. Compression connectors shall comply with the following:

1. Material: [Bronze] [Cast Copper] [ ]

2.5 GROUNDING WELL COMPONENTS

A. Grounding well components shall comply with the following:

1. Well Pipe: 8 inch diameter by 24 inch long [clay tile] [concrete] pipe with belled end.

2. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2.6 MANUFACTURERS

A. Products indicated shall be manufactured by one of the following (or equal):

1. Rods and Fittings:

Copperweld
Blackburn
Weaver

2. Compression Connectors:

Thomas and Bett

PART 3 -- EXECUTION

3.1 GENERAL

A. Embedded and buried ground connections shall be made by compression connectors utilizing diamond or hexagon dies and a hand compression tool for wire sizes 2 AWG and smaller and a hydraulic pump and compression head for wire sizes 2/0 AWG and larger. Compression connections shall be prepared in accordance with the manufacturer's instructions. Exposed ground connections to equipment shall be made by bolted clamps unless otherwise indicated. Solder shall not be used in any part of the ground circuits.

B. Embedded ground cables and fittings shall be securely attached to concrete reinforcing steel with tie wires and prevented from displacement during concrete placement. As each part of the grounding system which is laid below finished grade is completed, the CONSTRUCTION MANAGER shall be notified [ ] [2] hours prior to backfilling.

C. Grounding conductors which are extended beyond concrete surfaces for equipment connection shall be extended a sufficient length to reach the final connection point without splicing. Minimum extension shall be 3 feet. Grounding conductors which project from a concrete surface shall be located as close as possible to a corner of the equipment pad, protected by conduit, or terminated in a flush grounding plate. Exposed grounding conductors shall be supported by noncorrosive metallic hardware at 4-foot intervals

maximum Grounding conductors for future equipment shall be terminated using a two-hole copper flush mounted grounding plate.

D. Grounding conductor shall not be used as a system neutral.

E. Lightning arresters shall be directly connected to the ground system using copper conductors.

3.2 FACILITY GROUNDING

A. Ground continuity throughout the facility shall be maintained by installing an electrically-continuous metallic raceway system,[or a non-metallic raceway with a grounding conductor].

B. Metallic raceway shall be installed with double lock nuts or hubs at enclosures. Metallic conduits shall be assembled to provide a continuous ground path. Metallic conduits shall be bonded using insulated grounding bushings and shall be connected to the grounding system. Cable trays shall have No. 2/0 AWG bare copper ground conductor run on the outside of each tray. Conductor shall be connected to each section or fitting using a carriage bolt and clamp.

C. [Non-metallic raceway containing dc conductors operating at more than 50 volts to ground, or any ac conductors, shall contain a copper grounding conductor either bare, or green if insulated. Such conductor shall be bonded to terminal and intermediate metallic enclosures.]

3.3 EQUIPMENT AND ENCLOSURE GROUND

A. Electrical and distribution equipment and metal equipment platforms which support any electrical equipment shall be bonded to the nearest ground bus or to the nearest switchgear ground bus. This grounding requirement is in addition to the indicated raceway grounding.

B. Connection to ground electrodes and ground conductors shall be exothermic welded where concealed and shall be bolted pressure type where exposed. Bolted connectors shall be assembled wrench-tight.

C. Insulated grounding bushings shall be employed for all grounding connections to steel conduits in switchboards, in motor control centers, in pullboxes, and elsewhere where conduits do not terminate at a hub or a sheet metal enclosure.

D. Where insulated bushings are required, they shall be installed in addition to double lock-nuts.

E. Shielded power cable shall have its shield grounded at each termination in a manner recommended by the cable manufacturer. Shielded instrumentation cable shall be grounded at one end only; this shall be at the Motor Control Board or otherwise at the "receiving" end of the signal carried by the cable except as otherwise indicated. Termination of each shield drain wire shall be on its own terminal screw. All of these terminal screws in one rack shall be connected with No. 16 solid tinned bare copper wire jumper; connection to ground shall be accomplished with a No. 12 green insulated conductor to the main ground bus.

F. Nonelectrical equipment with metallic enclosures shall be connected to the grounding system.

3.4 ISOLATED GROUNDING

A. Where the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, an additional isolated ground conductor from the equipment through the instrument power panel for connection to a single point ground bus in the automatic transfer switch enclosure shall be provided. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors.

B. The neutral conductor from the ultra-isolation transformers shall be grounded only at the single point ground bus in the automatic transfer switch.

3.5 EXAMINATION

A. The WORK of this Section includes verification that final backfill and compaction has been completed before driving rod electrodes.

3.6 INSTALLATION

A. Rod electrodes [and additional rod electrodes as required to achieve specified resistance to ground] shall be installed at locations indicated.

B. Grounding well pipes with cover shall be installed at [each rod location] [rod locations where indicated] with well pipe top flush with finished grade.

[C. Number [4] [ ] AWG bare copper wire shall be installed in foundation footing [where indicated].]

[C. Grounding electrode conductor shall be installed and connected to reinforcing steel in foundation footing [where indicated]. [Steel shall be bonded together].]

D. Metal siding not attached to grounded structure shall be bonded together and to ground.

E. Reinforcing steel and metal accessories shall be bonded to structures.

F. Transient suppression plates shall be installed [where indicated] [ ].

G. Ground grid shall be installed under access floors [where indicated]. Grid shall be constructed of [2] [ ] AWG bare copper wire installed on 24 inch centers both ways. Each access floor pedestal shall be bonded to grid.

H. Metallic raceway, pipe, duct and other metal object entering [space under access floors] [ ] shall be bonded together [and to underfloor ground grid] using [2] [ ] AWG bare copper conductor.

I. Isolated grounding conductors shall be installed for circuits supplying [personal computers] [and] [ ].

[J. Where equipment grounding conductors are indicated, separate insulated conductors shall be installed within each feeder [and branch] circuit raceway. Ends shall be terminated on suitable lug, bus, or bushing.]

3.7 FIELD QUALITY CONTROL

A. Grounding and bonding system conductors and connections shall be inspected for tightness and proper installation.

3.8 GROUNDING SYSTEM TESTS

A. Suitable test instruments shall be used to measure resistance to ground of system. Testing shall be performed in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

B. The grounding test shall comply with IEEE Standard 81. A plot of ground resistance readings for each isolated ground rod or ground mat shall be submitted on 8-1/2 x 11 inch size graph paper. The current reference rod shall be driven at least 100 feet from the ground rod or grid under test. The measurements shall be made at 10-foot intervals beginning 25 feet from the test electrode and ending 75 feet from it, in direct line between the ground rod or center of grid and the current reference electrode.

C. A grounding system that shows greater than [2] [ ] ohm resistance for the flat portion of the plotted data shall be considered inadequately grounded. Additional parallel connected ground rods and/or deeper driven rods shall be provided until the ground resistance measurements complies with the indicated requirements. Use of salts, water or compounds to attain the specified ground resistance is not acceptable.

** END OF SECTION **