	Title: YALE OFFICE OF FACILITIES PROCEDURE MANUAL Chapter: 01 - Yale Design Standard Division: Electrical Standards	Section: 26 05 26 Grounding and Bonding for Electrical Systems
		Date: 6/15/16
		Author: Office of Facilities
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Date	Description of Change	Pages / Sections Modified	ID
6/15/16	Updated format, division title, and removed references to other sections.	-	mgl44

## A. Summary


This section contains design criteria for the grounding of building services and separately-derived systems under 600 volts. “Building service” can refer to utility services or services originating in other Yale University buildings. This section also contains design criteria for grounding and bonding electrical equipment.

## B. System Design and Performance Requirements

1. Ground all equipment with insulated ground wires run in conduit with circuit conductors. Construct metal raceway systems to create an independent and redundant ground path bonded to the ground wire at all boxes and enclosures. Provide another redundant ground where nonmetallic conduits are used (for example, ground rods at site lighting fixtures).
2. For all circuits of systems over 50 volts to ground, include an insulated equipment grounding wire sized according to NEC requirements. In addition, design metal raceway systems to serve as a redundant grounding conductor, and bond the insulated grounding wire to the metal raceway system at all terminations.
3. Where isolated grounding systems are provided, provide an additional insulated grounding wire to serve isolated ground terminals. Isolated ground wire conductor shall be green with yellow tracer.
4. Provide all building services with a minimum of two grounding electrodes described by the NEC and bonded together to form a grounding electrode system.
5. Ensure that all grounding electrode system bonding conductors are the same size and type as the grounding electrode conductor from the system neutral connection and are run within a separate and independent conduit system.
  - a. Make connections to metal underground water piping within five feet of the point at which the pipe enters the building. Also, all water meters in piping shall have ground conductor jumper across the meter.

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- b. Effectively ground metal building frames by using connections to concrete-encased electrodes within the foundation, a ground ring encircling the building, or driven ground rods, but no less than six feet apart.
  - c. Provide concrete-encased electrodes and ground rings for all new buildings.
  - d. Where ground rods are provided, install a minimum of three ¾” by 10 feet long copper clad ground rods, and bond them together to form a grounding electrode. The three grounding electrodes shall be spaced in a triad arrangement six feet apart or at a minimum distance equal to the depth of the rods.
6. Do not bond neutral conductors to grounding conductors at locations other than those specifically allowed by the NEC. Connect generators to wiring systems by transfer switches employing solid neutrals. Do not bond grounding conductors to neutral conductors at generators.
7. Where a special grounding system (for example, an isolated ground or ground grid) is provided for sensitive electronic equipment, bond the grounding system to the equipment grounding conductor only at the grounding system's point of connection to the system neutral conductor. Special grounding systems that are completely isolated from the building's normal equipment grounding system are never acceptable. Where shielded isolation transformers are provided, bond the electrostatic shield to the primary circuit equipment grounding conductor.
8. On construction drawings, indicate all required methods of service grounding and separately derived system grounding by specific details or notes. References to NEC requirements without such details or notes is not acceptable.
9. All new building modifications shall provide and install a building ground loop which will contain ground rods at 100’ apart. This ground loop shall be connected to electrical service ground and main water pipe. Grounding cable shall be independent of all other conduit systems.
10. Ensure that all building main service transformers are wired to the main electrical room individually. Wire the ground bus to the water main. The size of the conductor is determined by the NEC 250.30 and NEC 250.104. Duplex switchgears, double-ended substations, 300 kVA or larger transformers, motor control centers, and other major electrical equipment shall be grounded in two

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locations on that equipment with 4/0 size of conductor tying to the building ground. Major pieces of mechanical equipment such as chillers, air compressors, mechanical skid package frames have to be grounded with 4/0 conductor to building ground.

### **C. Product Standards**

Ensure that all products conform to the requirements contained in UL 467, Electrical Grounding and Bonding Equipment.

### **D. Manufacturers**


Any products that meet the materials requirements are acceptable.

### **E. Materials**

1. Use copper-clad steel ground rods with a minimum diameter of 3/4 inches and a minimum length of 10 feet. Where longer rods are required, use 1-inch diameter sectional rods.
2. For grounding conductors, use green insulated building wire, as described in Conductors and Cables.
3. Connectors used for grounding must meet the following requirements:
  - a. Mechanical connectors shall be cast bronze. Connectors used in branch circuits with #14 to #10 AWG solid conductors may be spring wire connectors with a green plastic shell, designed for grounding.
  - b. Compression connectors must be copper.
  - c. Welded connections must be exothermic-type and copper.

### **F. Preparation**

1. Where new feeders terminate in existing switchboards that do not contain grounding busses, specify new copper grounding busses sized at 20 percent of the phase busses, located at the bottom of the enclosures, and extending the full width of the enclosures.
2. Where new circuits terminate in existing panelboards and the ground bar is full or

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does not exist, specify a new ground bar.


## **G. Installation Guidelines**

1. Where ground grids are required under raised floors, specify #2 AWG bare copper conductors in each direction on 24-inch centers with cross-type compression connectors where grid conductors cross. Bond each item of equipment in room individually to the grid and to the isolated grounding conductor. Bond the grid directly to the isolated grounding conductor. Where necessary, bond the grid to each floor pedestal.
2. For buildings with metal siding that does not have an electrical connection to a metal building structure, bond the siding to equipment grounding conductors in panelboards at a minimum two, diametrically opposite locations.
3. Provide ground busses in all access holes and vaults containing circuits operating over 600 volts.
4. Specify new insulated or isolated ground bar for all panelboards through which isolated grounding conductors are run.
5. Do not bond isolated grounding conductors to equipment grounding conductors at locations other than at the point where system neutral is bonded to grounding electrodes. In small projects where new wiring does not extend beyond a local panelboard, insulated or isolated ground bar may be bonded to equipment ground bar in the panelboard.
6. At isolated grounding receptacles, bond the equipment grounding conductor to the box.
7. A ground ring encircling a building shall be buried at a depth of not less than 30" below the earth's surface.

## **H. Quality Control**

Test the resistance to ground of all grounding electrodes under any of the following conditions, and submit the test results to Yale University.

- Where new low voltage building services are installed.
- Where existing low voltage building services are upgraded.

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- Where new or replacement grounding electrodes are installed or newly connected.

“END OF SECTION”