

National Electrical Code® Requirements and BURNDY® Products Handbook



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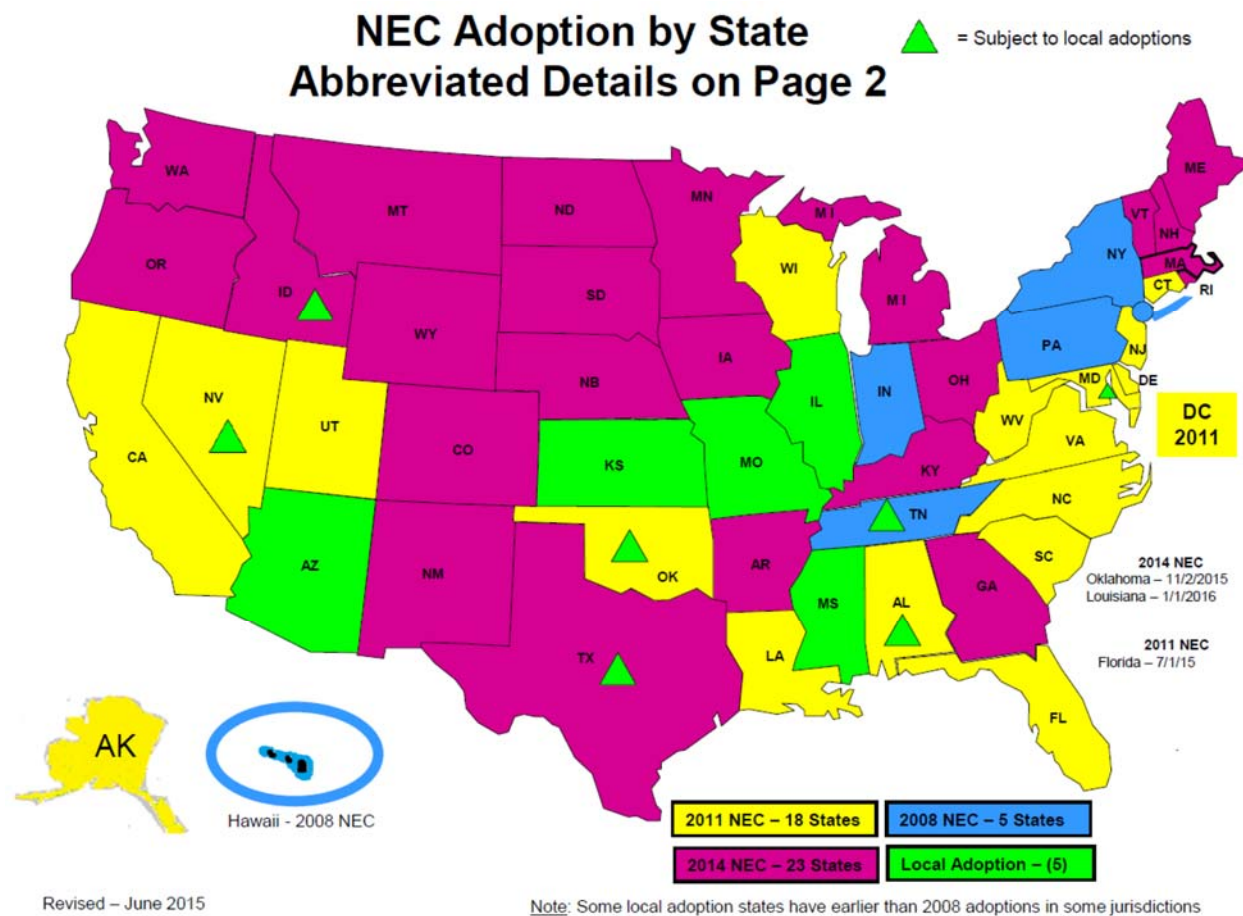
Disclaimer:

The National Fire Protection Association did not produce, review or approve this Handbook and assumes no responsibility for the application or use of any National Electrical Code related material or product set out herein.

National Electrical Code® Introduction

The National Electrical Code® is developed by NFPA®'s Committee on the National Electrical Code®, which consists of 19 (20 in 2008) code-making panels and a technical correlating committee. Work on the National Electrical Code® is sponsored by the National Fire Protection Association®. The National Electrical Code® is approved as an American National Standard by the American National Standards Institute (ANSI). It is formally identified as ANSI/NFPA 70®.

First published in 1897, the National Electrical Code® is updated and published every three years.



What is NFPA 70® (National Electrical Code®)?

Adopted in all 50 states, the National Electrical Code® is the benchmark for safe electrical design, installation, and inspection to protect people and property from electrical hazards

What does NFPA 70® (National Electrical Code®) address?

The National Electrical Code® addresses the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways in commercial, residential, and industrial occupancies.

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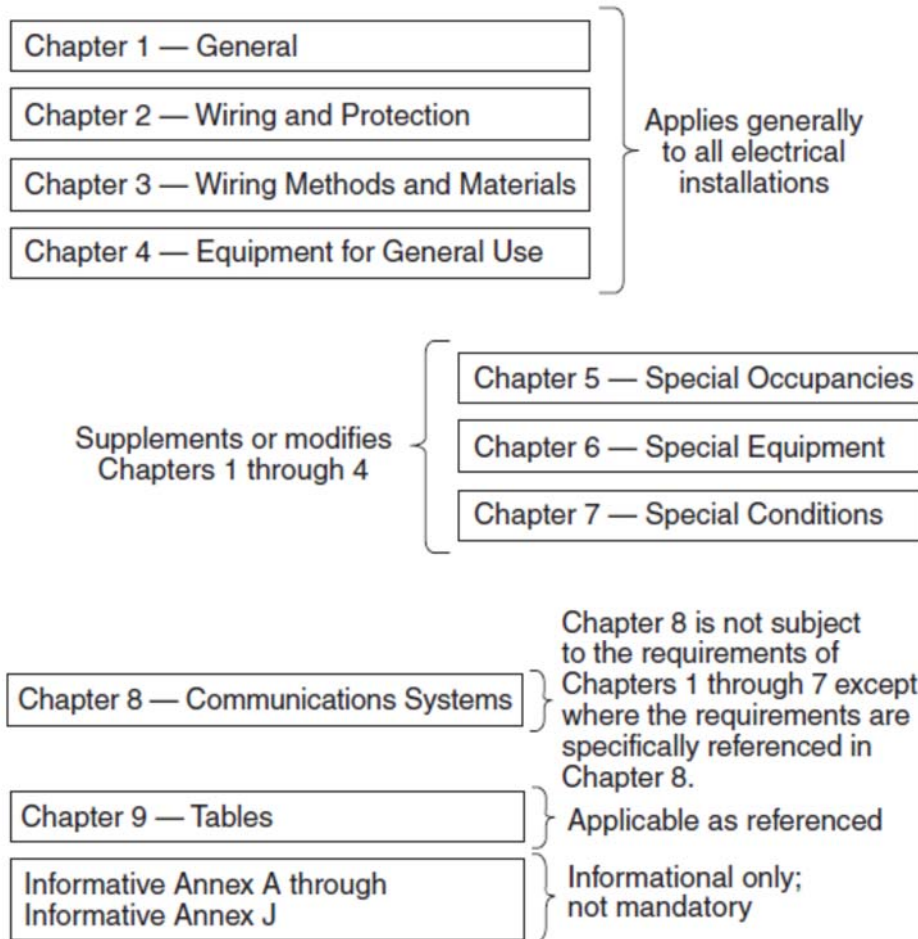
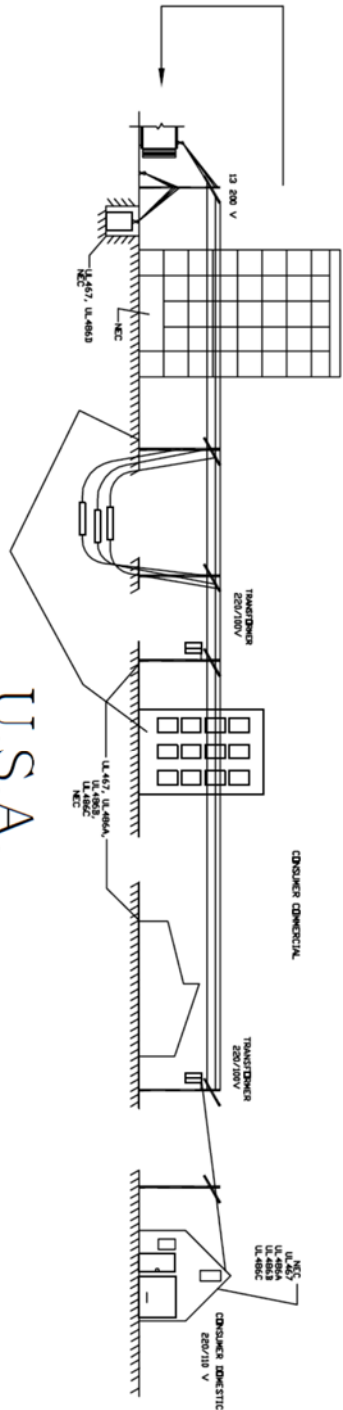
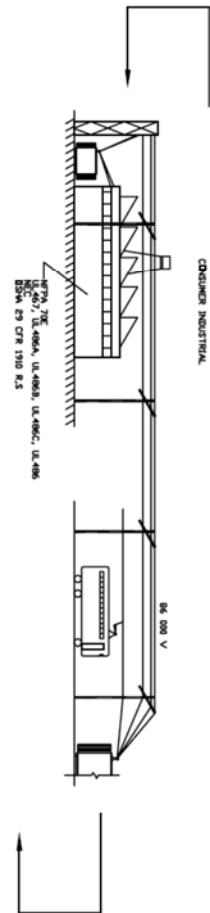
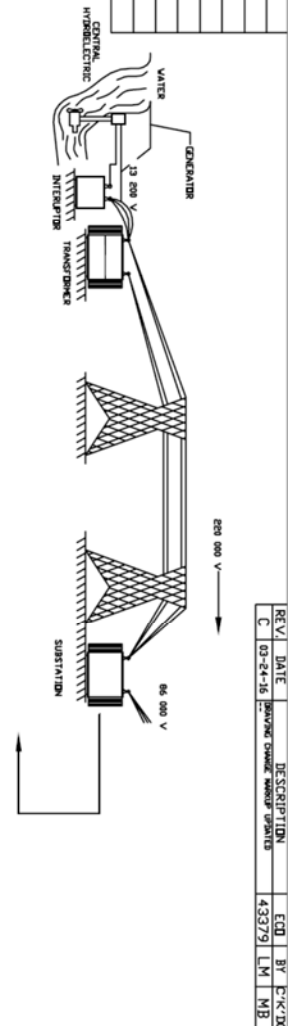


Figure 90.3 Code Arrangement from National Electrical Code® Article 90-Introduction, page 27

Note: Articles and clauses taken from the National Electrical Code® may not be complete. Refer to the National Electrical Code® for complete articles and clauses.

NUMBER	TITLE	MARKET
UL-4864-4868	WIRE CONNECTORS	CMAR
UL-48C	SPLICING WIRE CONNECTORS	CMAR
UL-486D	SEALED WIRE CONNECTOR SYSTEMS	CMAR
UL-447	GROUNDING & BONDING EGT.	CMAR
UL-2459	LUMINAIRE DISCONNECT	CMAR
UL-310	QUICK CONNECT TERMINALS	CMAR
NFPA 70	NATIONAL ELECTRICAL CODE	CMAR



U.S.A.

WHERE THE NFPA 70, NATIONAL ELECTRICAL CODE APPLIES

Definitions

Accessible (as applied to wiring methods). Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building.

Accessible, Ready (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.

Ampacity. The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Approved. Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Informational Note: The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA® documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.



This is the official that has the discretion to approve or disapprove an installation.

Automatic. Performing a function without the necessity of human intervention.

Bonded (Bonding). Connected to establish electrical continuity and conductivity.
The joining together of two or more metallic (conductive) objects.

Bonding Conductor or Jumper. A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.

Bonding Jumper, Equipment. The connection between two or more portions of the equipment grounding conductor.

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Bonding Jumper, Main. The connection between the grounded circuit conductor and the equipment grounding conductor at the service.

Bonding Jumper, System. The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system.

Branch Circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

Building. A structure that stands alone or that is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

Cabinet. An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

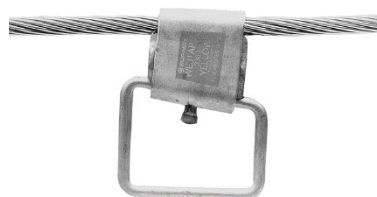
Communications Circuit. The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), outside wiring for fire alarm and burglar alarm from the communications utility to the customer's communications equipment up to and including terminal equipment such as a telephone, fax machine, or answering machine. (From Definitions in Article 800.1)

Conductor, Bare. A conductor having no covering or electrical insulation whatsoever.

Connector, Pressure (Solderless). A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.



Three Pressure Connector Examples



Device. A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function.

Disconnecting Means. A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

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Effective Ground-Fault Current Path. An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors.

Enclosed. Surrounded by a case, housing, fence, or wall(s) that prevents persons from accidentally contacting energized parts.

Enclosure. The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage.

Informational Note: See Table 110.28 for examples of enclosure types.

Energized. Electrically connected to, or is, a source of voltage.

Equipment. A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.
Connectors are considered equipment.

Exposed (as applied to wiring methods). On or attached to the surface or behind panels designed to allow access.

Feeder. All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.

Fitting. An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

Ground. The earth.

Ground Fault. An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth.

Grounded (Grounding). Connected (connecting) to ground or to a conductive body that extends the ground connection.

Grounded Conductor. A system or circuit conductor that is intentionally grounded.

Ground-Fault Current Path. An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, equipment, or the earth to the electrical supply source.

Informational Note: Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; steel framing members; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; and the earth itself.

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Ground-Fault Protection of Equipment. A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent device.

Grounding Conductor, Equipment (EGC). The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

Informational Note No. 1: It is recognized that the equipment grounding conductor also performs bonding.
Informational Note No. 2: See 250.118 for a list of acceptable equipment grounding conductors.

Grounding Electrode. A conducting object through which a direct connection to earth is established.

Grounding Electrode Conductor. A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.

Identified (as applied to equipment). Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular Code requirement.

Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organizations concerned with product evaluation.

Intersystem Bonding Termination. A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system. *(See 250.94). This device is used solely for communications circuits as defined above.*



BURNDY® Intersystem Bonding Termination

National Electrical Code® Requirements and BURNDY® Products Handbook

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

Informational Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. Use of the system employed by the listing organization allows the authority having jurisdiction to identify a listed product.



Examples of Listing Marks for the US

COMMENT: LISTED IS NOT APPROVED! LISTED MEANS THAT A PRODUCT WAS TESTED BY A NATIONALLY RECOGNIZED TESTING LABORATORY, MET THE REQUIREMENTS OF AN APPLICABLE STANDARD AND PLACED ON A LIST. The AHJ then reviews the installation and either approves or rejects it.

Luminaire. A complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire.

Plenum. A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

Qualified Person. One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Informational Note: Refer to NFPA 70E-2012, *Standard for Electrical Safety in the Workplace*, for electrical safety training requirements.

Raceway. An enclosed channel of metallic or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this *Code*.

Informational Note: A raceway is identified within specific article definitions.

Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

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Separately Derived System. An electrical source, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections.

Service. The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

Service Equipment. The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

Structure. That which is built or constructed.

Substation. An enclosed assemblage of equipment (e.g., switches, interrupting devices, circuit breakers, buses, and transformers) through which electric energy is passed for the purpose of distribution, switching, or modifying its characteristics.

Ungrounded. Not connected to ground or to a conductive body that extends the ground connection.

Voltage (of a circuit). The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned.

Informational Note: Some systems, such as 3-phase 4-wire, single-phase 3-wire, and 3-wire direct current, may have various circuits of various voltages

Section 110.14(D) – Electrical Connections

(D) Installation. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool shall be used to achieve the indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.^[1]

BTW30150

According to this clause, calibrated torque tools must be used to achieve specifically required torque values. BURNDY®'s torque wrenches are suitable for this application. In particular, the BTW30150 is a calibrated tool that delivers 125-150 lb-in of torque. Other BURNDY® torque wrenches can produce even greater torques. Annual calibration services are available and recommended by BURNDY®. Any inquiries can be directed to BURNDY® customer service.



BTW30150

Notes:

1. This clause will soon be added to the 2017 National Electrical Code®. The requirement will be implemented as each state adopts it.


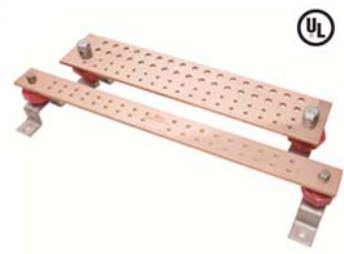
Article 250 • Grounding and Bonding

Section 250.8(A) – Connection of Grounding and Bonding Equipment

(A) **Permitted Methods.** Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:



- (1) Listed pressure connectors
- (2) Terminal bars
- (3) Pressure connectors listed as grounding and bonding equipment
- (4) Exothermic welding process
- (5) Machine screw-type fasteners that engage not less than two threads or are secured with a nut
- (6) Thread-forming machine screws that engage not less than two threads in the enclosure
- (7) Connections that are part of a listed assembly
- (8) Other listed means

BURNDY® Grounding and Bonding Connectors

Product	Description
<p>(1)</p> 	<p>BURNDY® Listed Pressure Connectors</p> <ul style="list-style-type: none"> • <i>UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements^[1]</i> • <i>UL listed & CSA certified Wire Connectors per UL486A-486B & CSA C22.2 No. 65 requirements</i> • <i>Available in many sizes and with various hole patterns</i> • <i>Lugs can be connected to busbar</i>
<p>(2)</p> 	<p>Type BBB BURNDY® Bus Bar</p> <ul style="list-style-type: none"> • <i>UL listed Grounding and Bonding Equipment per UL467 requirements</i> • <i>Available in many sizes and hole patterns</i> • <i>Brackets and insulators included with most styles</i>

Article 250 • Grounding and Bonding

Section 250.8(A) – Connection of Grounding and Bonding Equipment

Product	Description
<p>(3)</p> 	<p>Type YGHC-C HYTAP™ Connector</p> <ul style="list-style-type: none"> • <i>UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements</i> • <i>UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements</i> • <i>Acceptable for direct burial in earth and concrete</i>
<p>(4)</p> 	<p>BURNDYWeld® Exothermic</p> <ul style="list-style-type: none"> • <i>UL listed Grounding and Bonding Equipment per UL467 requirements^[1]</i> • <i>Used to weld a variety of materials for electrical purposes</i> • <i>No outside power required</i>

Notes:

1. Check the BURNDY® catalog for individual product information.

Section 250.10 – Protection of Ground Clamps and Fittings

Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.

BURNDY® Ground Access Wells

The rule's purpose is to help prevent BURNDY®'s grounding clamps from experiencing damage or mechanical failure. Failure can be prevented by adding the protective coating. In particular, the grounding clamps can be buried/covered in concrete provided that they are listed for direct soil burial or concrete encasement.



Ground Access
Wells

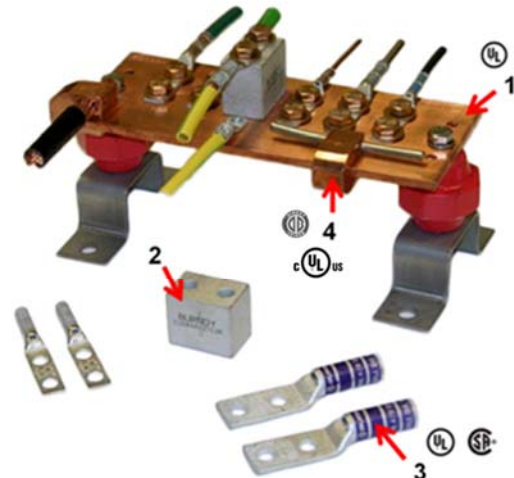
Article 250 • Grounding and Bonding

Section 250.24(A)(4) – Grounding Service-Supplied Alternating-Current Systems

(A) System Grounding Connections. (4) Main Bonding Jumper as Wire or Busbar. Where the main bonding jumper specified in 250.28⁽¹⁾ is a wire or busbar and is installed from the grounded conductor terminal bar or bus to the equipment grounding terminal bar or bus in the service equipment, the grounding electrode conductor shall be permitted to be connected to the equipment grounding terminal, bar, or bus to which the main bonding jumper is connected.

BURNDY® Lug on Busbar Connection

This rule lists the types of equipment that the grounding electrode conductor is allowed to terminate to.



BURNDY® Lugs on Busbar

1. Type BBB busbar (UL listed Grounding and Bonding Equipment per UL467)
2. Type CUSA stacking adapter
3. Type YA-L-2TC compression lug (UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements)
4. Type YG-B busbar connector (UL listed Grounding and Bonding Equipment per UL467 & certified to CSA C22.2 No. 41 requirements)

Notes:

1. Section 250.28 describes material, construction, attachment, and sizing requirements for main bonding jumpers and system bonding jumpers.

Article 250 • Grounding and Bonding

Section 250.30(A)(4) – Grounding Separately Derived Alternating-Current Systems

(A) Grounded Systems. (4) Grounding Electrode. The grounding electrode shall be as near as practicable to, and preferably in the same area as, the grounding electrode conductor connection to the system. The grounding electrode shall be the nearest of one of the following:

- (1) Metal water pipe grounding electrode as specified in 250.52(A)(1)
- (2) Structural metal grounding electrode as specified in 250.52(A)(2)

Exception No. 1: Any of the other electrodes identified in 250.52(A) shall be used if the electrodes specified by 250.30(A)(4) are not available.

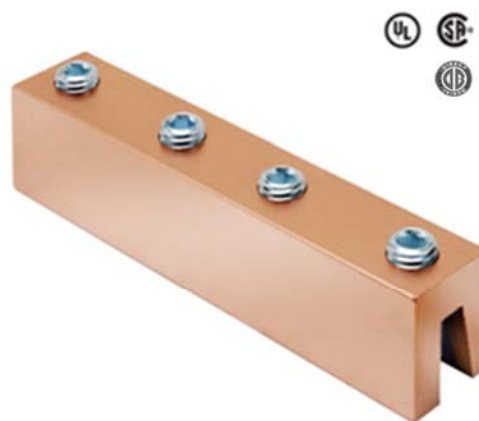
Exception No. 2 to (1) and (2): If a separately derived system originates in listed equipment suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted as the grounding electrode for the separately derived system.

BURNDY® Grounding Connectors

This section describes rules for grounding electrodes. It specifically refers to metal water pipe grounding electrodes and structural metal grounding electrodes. BURNDY®'s C-type Ground Clamp is UL listed Grounding and Bonding Equipment per UL467 & certified to CSA C22.2 No. 41 requirements. It is installed with a calibrated torque wrench and mechanically connects grounding conductor to water pipe. BURNDY®'s YGIB GROUNDLINK™ Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It provides a compression connection to structural metal.



C-type Ground Clamp



Type YGIB GROUNDLINK™ Connector

Article 250 • Grounding and Bonding



Section 250.30(A)(6)(c) – Grounding Separately Derived Alternating-Current Systems

(A) Grounded Systems. (6) Grounding Electrode Conductor, Multiple Separately Derived Systems. (c) Connections. All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

- (1) A connector listed as grounding and bonding equipment.
- (2) Listed connections to aluminum or copper busbars not smaller than 6 mm x 50 mm (1/4 in. x 2 in.). If aluminum busbars are used, the installation shall comply with 250.64(A).
- (3) The exothermic welding process.


Tap conductors shall be connected to the common grounding electrode conductor in such a manner that the common grounding electrode conductor remains without a splice or joint.

BURNDY® Connections to Grounding Electrode Conductor

Product	Description
<p>(1)</p> 	<p>Type YGHC-C HYTAP™ Connector</p> <ul style="list-style-type: none"> • <i>UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements</i> • <i>UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements</i> • <i>Acceptable for direct burial in earth and concrete</i>
<p>(2)</p> 	<p>Type YGA HYLUG™ Compression Terminal</p> <ul style="list-style-type: none"> • <i>UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements</i> • <i>UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements</i> • <i>Acceptable for direct burial in earth or concrete</i>

Article 250 • Grounding and Bonding

Section 250.30(A)(6)(c) – Grounding Separately Derived Alternating-Current Systems

Product	Description
<p>(3)</p> 	<p>BURNDYWeld® Exothermic</p> <ul style="list-style-type: none">• <i>UL listed Grounding and Bonding Equipment per UL467 requirements^[1]</i>• <i>Used to weld a variety of materials for electrical purposes</i>• <i>No outside power required</i>

Notes:

1. Check the BURNDY® catalog for individual product information.

Article 250 • Grounding and Bonding

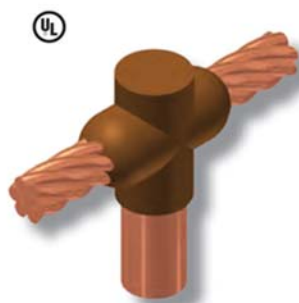
Section 250.50 – Grounding Electrode System

All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. Where none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used.^[1]

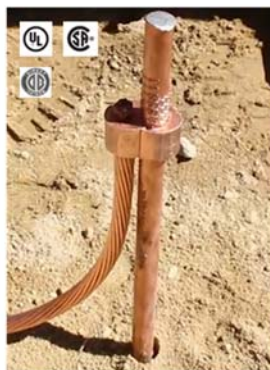
Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system where the steel reinforcing bars or rods are not accessible for use without disturbing the concrete.

BURNDY® Ground Rod Connections

This clause describes the basic rules for maintenance and additions to grounding systems. It is essential that grounding electrode systems comply with this section so that the fault currents can be safely carried to ground for a long period of time. There are three types of BURNDY® ground rod connections: an exothermic ground rod connection, a mechanical ground rod connection, and a compression ground rod connection. The mechanical Type GAR connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is acceptable for direct burial in earth and concrete: installed with a calibrated torque wrench. The exothermic Type BCR-2 Mold is UL listed Grounding and Bonding Equipment per UL467 requirements. The Type YGHP-C compression connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is also acceptable for direct burial in earth and concrete.



Exothermic



Compression



Mechanical

Notes:

1. Section 250.52(A) describes electrodes permitted for grounding. See pages 22-24 for more information.

Article 250 • Grounding and Bonding

Section 250.52(A)(1) – Grounding Electrodes

(A) Electrodes Permitted for Grounding. (1) Metal Underground Water Pipe. A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

BURNDY® Type GAR Connector

This clause describes metal underground water pipes that are permitted for grounding. BURNDY®'s Type GAR Mechanical Connectors can be attached to metal underground water pipes. The Type GAR Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is installed with a calibrated torque wrench.



Type GAR Mechanical Connector

Section 250.52(A)(3) – Grounding Electrodes

(3) Concrete-Encased Electrode. A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either (1) or (2):

- (1) At least one electrically conductive coated steel reinforcing bar, with minimum diameter of ½ in. and the necessary mechanical connections to construct an electrode of at least 6.0 m (20 ft) in length. This reinforcing bar could be zinc-galvanized or bare.
- (2) Bare copper conductor with minimum size of 4 AWG.

Metallic components shall be encased by at least 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

BURNDY® Type YSHG Connector

Concrete-encased electrodes are valuable because of their relatively low resistance. The reinforcing bar can also be galvanized for corrosion-resistance, meaning that it has a protective zinc layer. BURNDY® offers many connectors that are suitable for use on rebar, suitable for direct burial in concrete, and UL listed Grounding and Bonding Equipment per UL467 requirements. The BURNDY® Type YSHG Connector is one example of a connector that can be used with concrete-encased electrodes.



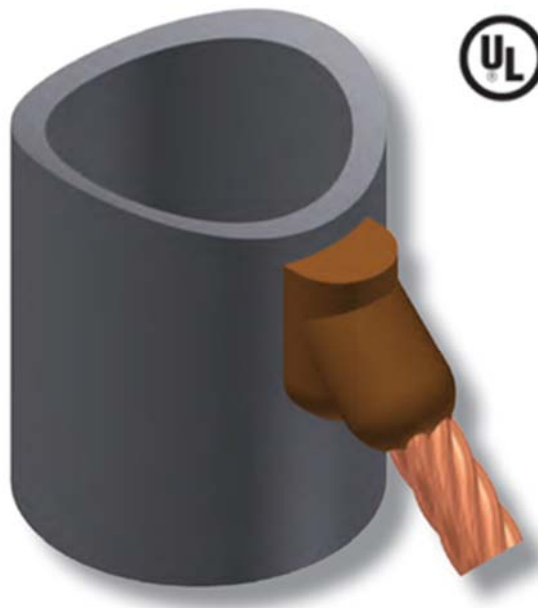
Type YSHG Connector Before Encasement

Section 250.52(A)(8) – Grounding Electrodes

(A) Electrodes Permitted for Grounding. (8) Other Local Metal Underground Systems or Structures. Other local metal underground systems or structures such as piping systems, underground tanks, and underground metal well casings that are not bonded to a metal water pipe.

BURNDYWeld® Type BCS-3 Exothermic Connection

According to this clause, local metal underground systems or structures are electrodes permitted for grounding. BURNDY® offers a line of BCS exothermic connections that can be used for piping systems, underground tanks, and underground metal well casings. BCS stands for “BURNDY® Cable to Steel” connection. The BURNDYWeld® Type BCS-3 Exothermic Connection is UL listed Grounding and Bonding Equipment per UL467 requirements.



Type BCS-3 Exothermic Connection

Section 250.53(D) – Grounding Electrode System Installation

(D) Metal Underground Water Pipe. If used as a grounding electrode, metal underground water pipe shall meet the following requirements:

- (1) **Continuity.** Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters or filtering devices and similar equipment.
- (2) **Supplemental Electrode Required.** A metal underground water pipe shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). If the supplemental electrode is of the rod, pipe, or plate type, it shall comply with 250.53(A). The supplemental electrode shall be bonded to a grounding electrode conductor, grounded service-entrance conductor, nonflexible grounded service raceway, any grounded service enclosure, or as provided by 250.32(B).

Exception: The supplemental electrode shall be permitted to be bonded to the interior metal water piping at any convenient point as specified in 250.68(C)(1), Exception.

BURNDY® Type GAR Connector

This clause describes requirements for installation of metal underground water pipes. BURNDY®'s Type GAR Mechanical Connectors can be attached to metal underground water pipes. The Type GAR Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is installed with a calibrated torque wrench.



Type GAR Mechanical Connector

Article 250 • Grounding and Bonding

Section 250.64(C) – Grounding Electrode Conductor Installation

(C) Continuous. Except as provided in 250.30(A)(5)^[1] and (A)(6)^[2], 250.30(B)(1)^[3], and 250.68(C)^[4], grounding electrode conductor(s) shall be installed in one continuous length without a splice or joint. If necessary, splices or connections shall be made as permitted in (1) through (4):

- (1) Splicing of the wire-type grounding electrode conductor shall be permitted only by irreversible compression type connectors listed as grounding and bonding equipment or by the exothermic welding process.
- (2) Sections of busbars shall be permitted to be connected together to form a grounding electrode conductor.
- (3) Bolted, riveted, or welded connections of structural metal frames of buildings or structures.
- (4) Threaded, welded, brazed, soldered or bolted-flange connections of metal water piping.

BURNDY® Type YGS HYLINK™ and Type BCC-1 Exothermic Connection

This clause describes rules for continuity of a grounding electrode conductor as well as rules for splices and connections. The Type YGS HYLINK™ Irreversible Compression Splice is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements, a UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements, and acceptable for direct burial in earth or concrete. The Type BCC-1 Exothermic Connection is UL listed Grounding and Bonding Equipment per UL467 requirements.



Type YGS HYLINK™



Type BCC-1 Exothermic Connection

Notes:

1. Section 250.30(A)(5) describes the rules for the grounding electrode conductor of a single separately derived system.
2. Section 250.30(A)(6) describes the rules for the grounding electrode conductor of a multiple separately derived system.
3. Section 250.30(B)(1) describes the rules for the grounding electrode conductor of an ungrounded separately derived system.
4. Section 250.68(C) describes rules for the locations of grounding electrode conductor and bonding jumper connections. See page 37 for more information.

Section 250.64(D)(1)(3) – Grounding Electrode Conductor Installation

Connections to an aluminum or copper busbar not less than 6 mm thick x 50 mm wide (1/4 in. thick x 2 in. wide) and of sufficient length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. If aluminum busbars are used, the installation shall comply with 250.64(A), which states that the aluminum busbars cannot be in contact with masonry, exposed to corrosive conditions, or within 18 inches of the earth.

BURNDY® Type YGA and Type YGHA HYLUG™ Compression Terminals

This rule describes an allowable method for connecting a grounding electrode conductor tap to a grounding electrode conductor. It is essential that the busbar be fastened for safety/reliability and installed in an accessible location, allowing for removal and exposure. The Type YGA and Type YGHA HYLUG™ can be used for this connection to busbar: they are UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements.



Type YGA HYLUG™

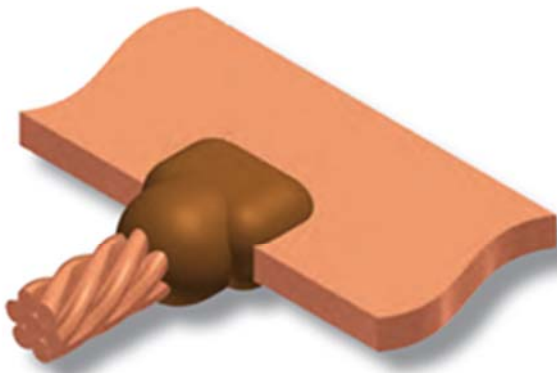


Type YGHA HYLUG™

Section 250.64(D)(1)(3) – Grounding Electrode Conductor Installation

BURNDY® Exothermic Weld and Type YG-B HYGROUND® Connector

It is essential that the busbar be fastened for safety/reliability and installed in an accessible location, but some specifications call for a permanent connection between the grounding electrode conductor and the busbar. Therefore an exothermic weld and the Type YG-B HYGROUND® connector will be in compliance. The Type YG-B compression connector is UL listed Grounding and Bonding Equipment per UL467 & certified to CSA C22.2 No. 41 requirements and a UL listed Wire Connector per UL486A-486B & certified to CSA C22.2 No. 65 requirements. It is also rated for direct burial.



Exothermic Weld



Type YG-B HYGROUND® Connector

Article 250 • Grounding and Bonding

Section 250.64(D)(3) – Grounding Electrode Conductor Installation

(D) Building or Structure with Multiple Disconnecting Means in Separate Enclosures. (3) Common Location. A grounding electrode conductor shall be connected in a wireway or other accessible enclosure on the supply side of the disconnecting means to one or more of the following, as applicable:

- (1) Grounded service conductor(s)
- (2) Equipment grounding conductor installed with the feeder
- (3) Supply-side bonding jumper

The connection shall be made with exothermic welding or a connector listed as grounding and bonding equipment. The grounding electrode conductor shall be sized in accordance with 250.66 based on the service-entrance or feeder conductor(s) at the common location where the connection is made.

BURNDY® Grounding Electrode Conductor Connectors

This clause describes the rules for connecting a grounding electrode conductor to a wireway. There are three types of BURNDY® grounding electrode conductor connections: an exothermic electrode connection, a compression electrode connection, and a mechanical electrode connection. The Type BCC-7 Exothermic Connection is UL listed Grounding and Bonding Equipment per UL467 requirements. The Type KS SERVIT® is UL listed Grounding and Bonding Equipment per UL467 requirements, acceptable for direct burial in earth or concrete, and installed with a calibrated torque wrench. The Type YGHC-C HYTAP™ Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements and acceptable for direct burial in earth or concrete.



Type BCC-7 Exothermic Connection



Type YGHC-C HYTAP™ Connector



Type KS SERVIT®

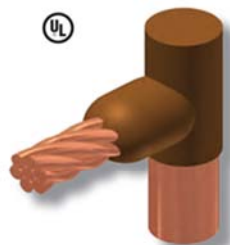
Section 250.64(F) – Grounding Electrode Conductor Installation

(F) Installation to Electrode(s). Grounding electrode conductor(s) and bonding jumpers interconnecting grounding electrodes shall be installed in accordance with (1), (2), or (3). The grounding electrode conductor shall be sized for the largest grounding electrode conductor required among all the electrodes connected to it.

- (1) The grounding electrode conductor shall be permitted to be run to any convenient grounding electrode available in the grounding electrode system where the other electrode(s), if any, is connected by bonding jumpers that are installed in accordance with 250.53(C).
- (2) Grounding electrode conductor(s) shall be permitted to be run to one or more grounding electrode(s) individually.
- (3) Bonding jumper(s) from grounding electrode(s) shall be permitted to be connected to an aluminum or copper busbar not less than 6 mm x 50 mm (¼ in. x 2 in.). The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. The grounding electrode conductor shall be permitted to be run to the busbar. Where aluminum busbars are used, the installation shall comply with 250.64(A).

BURNDY® Ground Rod Connections

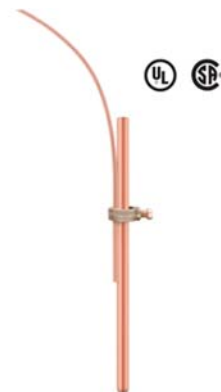
This clause describes the rules for installation of grounding electrode conductor(s) and bonding jumpers. It is essential that grounding electrode systems comply with this section so that the fault currents can be safely carried to ground. There are three types of BURNDY® ground rod connections: an exothermic ground rod connection, a mechanical ground rod connection, and a compression ground rod connection. The mechanical Type GRC connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is acceptable for direct burial in earth and concrete: installed with a calibrated torque wrench. The exothermic Type BCR-1 Mold is UL listed Grounding and Bonding Equipment per UL467 requirements. The Type YGLR-C compression connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is also acceptable for direct burial in earth and concrete.



Exothermic



Compression



Mechanical

Article 250 • Grounding and Bonding

Section 250.66 – Size of Alternating-Current Grounding Electrode Conductor

The size of the grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system of a grounded or ungrounded ac system shall not be less than given in Table 250.66, except as permitted in 250.66(A) through (C).

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors ^a (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum ^b
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Notes:

1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.

2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

^aThis table also applies to the derived conductors of separately derived ac systems.

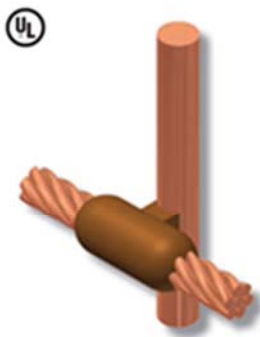
^bSee installation restrictions in 250.64(A).

Article 250 • Grounding and Bonding

Section 250.66 – Size of Alternating-Current Grounding Electrode Conductor

BURNDY® Ground Rod Connections

It is essential that grounding electrode conductor sizing complies with this section so that the fault currents can be safely carried to ground. Table 250.66 is used to size the grounding electrode conductor when the conditions of 250.66(A), (B), or (C) do not apply.^[1] There are three types of BURNDY® ground rod connections: an exothermic ground rod connection, a mechanical ground rod connection, and a compression ground rod connection. The mechanical Type GRC connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is acceptable for direct burial in earth and concrete: installed with a calibrated torque wrench. The exothermic Type BCR-3 Mold is UL listed Grounding and Bonding Equipment per UL467 requirements. The Type YGHP-C compression connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is also acceptable for direct burial in earth and concrete.



Exothermic



Mechanical



Compression

Article 250 • Grounding and Bonding

Section 250.66(A) – Size of Alternating-Current Grounding Electrode Conductor

(A) Connections to a Rod, Pipe, or Plate Electrode(s). Where the grounding electrode conductor is connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as permitted in 250.52(A)(5) or (A)(7), that portion of the conductor that is the sole connection to the grounding electrode(s) shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

BURNDY® Type YGLR-C GRIDLOK™ Connector

This clause describes the first exception to Table 250.66: when the grounding electrode conductor is connected to a rod, pipe, or plate electrode. Smaller wires are acceptable for this situation. BURNDY®'s Type YGLR-C GRIDLOK™ Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements and acceptable for direct burial in earth and concrete.



Type YGLR-C GRIDLOK™ Connector

Article 250 • Grounding and Bonding

Section 250.66(B) – Size of Alternating-Current Grounding Electrode Conductor

(B) Connections to Concrete-Encased Electrodes. Where the grounding electrode conductor is connected to a single or multiple concrete-encased electrode(s) as permitted in 250.52(A)(3)^[1], that portion of the conductor that is the sole connection to the grounding electrode(s) shall not be required to be larger than 4 AWG copper wire.

BURNDY® Type YGHP-C HYTAP™ Connector

This clause describes the second exception to Table 250.66: when the grounding electrode conductor is connected to a concrete-encased electrode. BURNDY®'s grounding electrode conductors are not required to be a particular size. The BURNDY® Type YGHP-C HYTAP™ Connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements and acceptable for direct burial in earth and concrete. It can be used for a compressive connection to rebar.



Type YGHP-C HYTAP™ Connector

Notes:

1. Section 250.52(A)(3) describes the two types of concrete-encased electrodes that are permitted for grounding. See page 23 for more information.

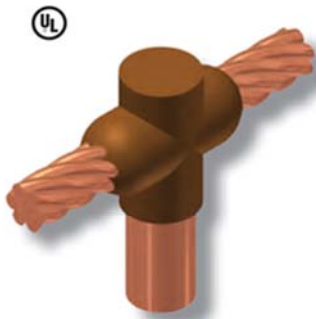
Article 250 • Grounding and Bonding

Section 250.68 – Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes

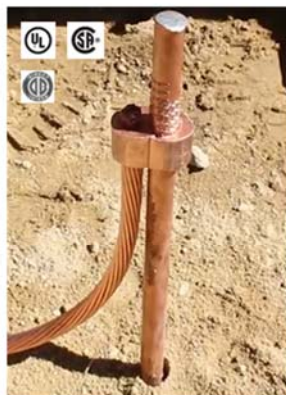
The connection of a grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system and associated bonding jumper(s) shall be made as specified 250.68(A) through (C).

BURNDY® Ground Rod Connections

This clause describes rules for connecting a grounding electrode conductor. It is essential that grounding electrode conductors comply with this section so that the fault currents can be safely carried to ground. There are three types of BURNDY® ground rod connections: an exothermic ground rod connection, a mechanical ground rod connection, and a compression ground rod connection. The mechanical Type GAR connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is acceptable for direct burial in earth and concrete: installed with a calibrated torque wrench. The exothermic Type BCR-2 Mold is UL listed Grounding and Bonding Equipment per UL467 requirements. The Type YGHP-C compression connector is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It is also acceptable for direct burial in earth and concrete.



Exothermic



Compression



Mechanical

Article 250 • Grounding and Bonding

Section 250.68(A) – Termination to the Grounding Electrode

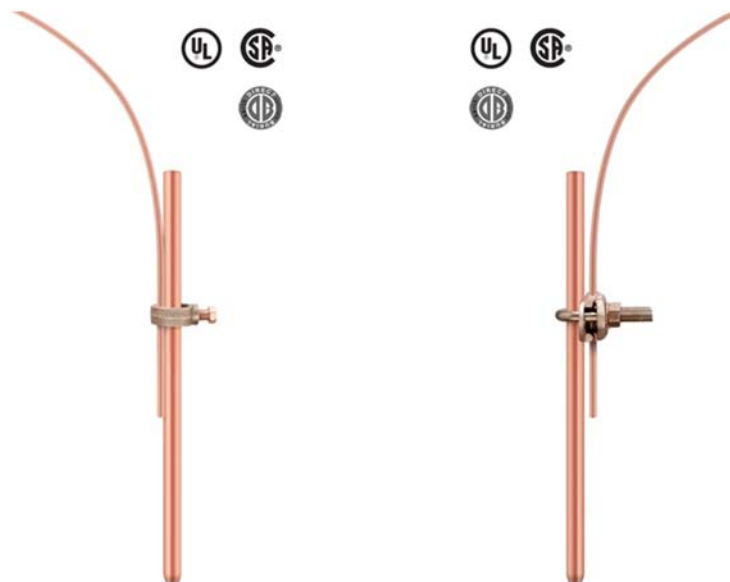
(A) Accessibility. All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode shall be accessible.

Exception No. 1: An encased or buried connection to a concrete-encased, driven, or buried grounding electrode shall not be required to be accessible.

Exception No. 2: Exothermic or irreversible compression connections used at terminations, together with the mechanical means used to attach such terminations to fireproofed structural metal whether or not the mechanical means is reversible, shall not be required to be accessible.

BURNDY® Mechanical Ground Rod Connections

With two exceptions, this clause requires relevant mechanical elements to be accessible. According to 250.70, if the grounding electrode attachment fitting is encased in concrete or buried in the earth, it must be listed for direct soil burial or concrete encasement. If BURNDY®'s mechanical elements are accessible, then they can be removed or exposed without damaging the building structure. The mechanical Type GAR and Type GRC connectors (shown below) are UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. They are listed for direct burial in earth and concrete: installed with a calibrated torque wrench.



Mechanical Ground Rod Connections

Article 250 • Grounding and Bonding

Section 250.68(C) – Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes

(C) Grounding Electrode Connections. Grounding electrode conductors and bonding jumpers shall be permitted to be connected at the following locations and used to extend the connection to an electrode(s):

- (1) Interior metal water piping located not more than 1.52 m (5 ft) from the point of entrance to the building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system.

Exception: In industrial, commercial, and institutional buildings or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor, if the entire length, other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.

- (2) The metal structural frame of a building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor.
- (3) A concrete-encased electrode of either the conductor type, reinforcing rod or bar installed in accordance with 250.52(A)(3) extended from its location within the concrete to an accessible location above the concrete shall be permitted.

BURNDY® Connectors

This clause describes rules for connection to grounding electrodes. The Type GAR Mechanical Connector is installed with a calibrated torque wrench and is attached to interior metal water piping. It is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. The Type YGIB GROUNDLINK™ can be used for the metal structural frame of a building. It is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. The Type YGHP-C HYTAP™ Connector can be used for concrete-encased electrodes. It is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements and also a UL listed & CSA certified Wire Connector per UL486A-486B & CSA C22.2 No. 65 requirements.



Type GAR Mechanical Connector



Type YGIB GROUNDLINK™



Type YGHP-C HYTAP™ Connector

Article 250 • Grounding and Bonding

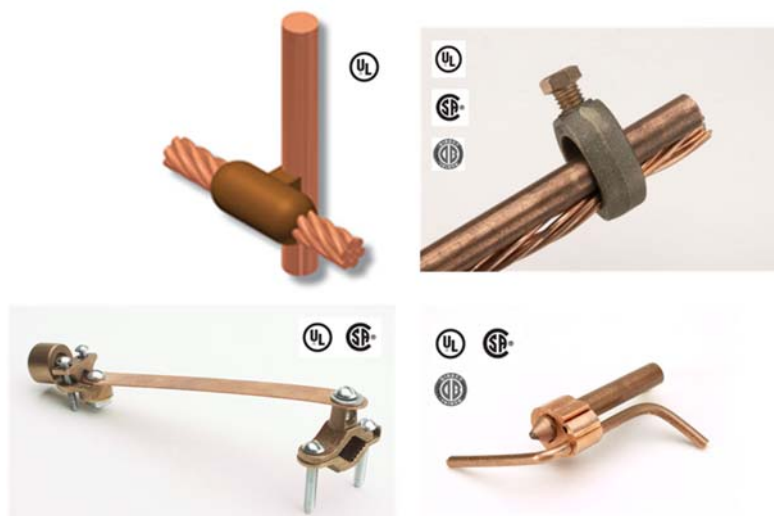
Section 250.70 – Methods of Grounding and Bonding Conductor Connection to Electrodes

The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means. Connections depending on solder shall not be used. Ground clamps shall be listed for the materials of the grounding electrode and the grounding electrode conductor and, where used on pipe, rod, or other buried electrodes, shall also be listed for direct soil burial or concrete encasement. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is listed for multiple conductors. One of the following methods shall be used:

- (1) A pipe fitting, pipe plug, or other approved device screwed into a pipe or pipe fitting
- (2) A listed bolted clamp of cast bronze or brass, or plain or malleable iron
- (3) For indoor communications purposes only, a listed sheet metal strap-type ground clamp having a rigid metal base that seats on the electrode and having a strap of such material and dimensions that it is not likely to stretch during or after installation
- (4) An equally substantial approved means

BURNDY® Ground Rod Connections

This clause describes the rules for connecting a grounding and bonding conductor to an electrode. It is essential that grounding electrode systems comply with this section so that the fault currents can be safely carried to ground. Four types of ground rod connections are shown below: an exothermic ground rod connection, two mechanical ground rod connections (installed with a calibrated torque wrench), and a compression ground rod connection. The mechanical and compression connections shown are UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. The exothermic connection shown is UL listed Grounding and Bonding Equipment per UL467 requirements.



Ground Rod Connections

Section 250.94 – Bonding for Other Systems

An intersystem bonding termination for connecting intersystem bonding conductors required for other systems shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures. The intersystem bonding termination must satisfy requirements (1) through (6).

Exception: At existing buildings/structures, an external accessible means for bonding communications systems together can be fulfilled by a:

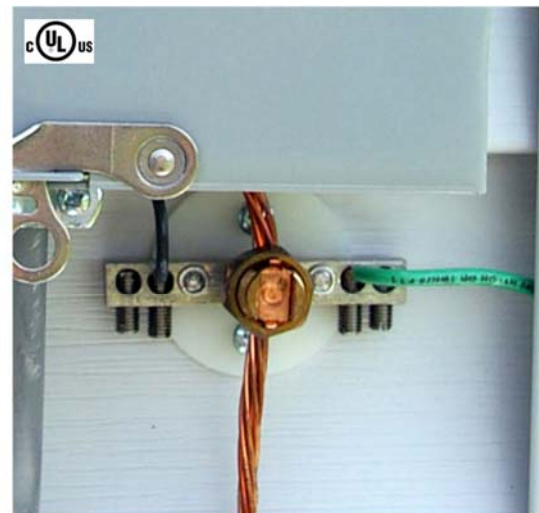
- (1) Exposed nonflexible metallic raceway
- (2) An exposed grounding electrode conductor
- (3) Connection of a corrosion-resistant conductor approved by the authority having jurisdiction

BURNDY® BONDIT® Intersystem Bonding Connectors

This clause describes the rules for an intersystem bonding termination. The BDTIBB Intersystem Bonding Connector connects to phone, cable TV, ground conductor, and satellite dish. It is UL listed Grounding and Bonding Equipment per UL467 requirements. The BDT1 Intersystem Bonding Connector is made in the USA. It is UL listed Grounding and Bonding Equipment per UL467 & certified to CSA C22.2 No. 41 requirements.



BDTIBB Intersystem Bonding Connector



BDT1 Intersystem Bonding Connector

Section 250.104 – Bonding of Piping Systems and Exposed Structural Metal

(A) **Metal Water Piping.** The metal water piping systems shall be bonded as required in (A)(1), (A)(2), or (A)(3) of this section. The bonding jumper(s) shall be installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible.

(B) **Other Metal-Piping Systems.** If installed in, or attached to, a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

- (1) Equipment grounding conductor for the circuit that is likely to energize the piping system
- (2) Service equipment enclosure
- (3) Grounded conductor at the service
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used

The bonding conductor(s) or jumper(s) shall be sized in accordance with 250.122, using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

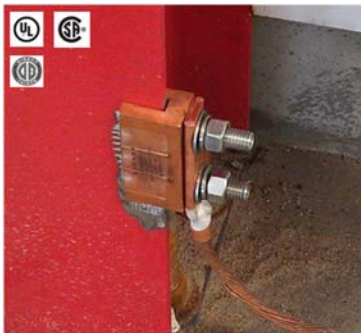
(C) **Structural Metal.** Exposed structural metal that is interconnected to form a metal building frame and is not intentionally grounded or bonded and is likely to become energized shall be bonded to the service equipment enclosure; the grounded conductor at the service; the disconnecting means for buildings or structures supplied by a feeder or branch circuit; the grounding electrode conductor, if of sufficient size; or to one or more grounding electrodes used. The bonding jumper(s) shall be sized in accordance with Table 250.66 and installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A), Exception No. 2.

(D) **Separately Derived Systems.** Metal water piping systems and structural metal that is interconnected to form a building frame shall be bonded to separately derived systems in accordance with (D)(1) through (D)(3).

Section 250.104 – Bonding of Piping Systems and Exposed Structural Metal

BURNDY® Connectors

This section describes the rules for bonding of piping systems and exposed structural metal. Three types of relevant BURNDY® connections are shown below: a Type YGIB Compression GROUNDLINK™ Connector, an Exothermic Type BCS-3 mold, and a Type GAR Mechanical Connector. The Type YGIB and Type GAR connectors are UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. The Type GAR Connector is installed with a calibrated torque wrench. The Type BCS-3 connection is UL listed Grounding and Bonding Equipment per UL467 requirements.



Type YGIB GROUNDLINK™



Type BCS-3 Exothermic Connection



Type GAR Mechanical Connector

Article 250 • Grounding and Bonding

Section 250.122(B) – Size of Equipment Grounding Conductors

(B) Increased in Size. Where ungrounded conductors are increased in size from the minimum size that has sufficient ampacity for the intended installation, wire-type equipment grounding conductors, where installed, shall be increased in size proportionately according to the circular mil area of the ungrounded conductors.

BURNDY® Type YGA and Type YGHA HYLUG™ Compression Terminals

According to this rule, the ratio between the sizes of the equipment grounding conductor and the ungrounded conductor must be maintained. BURNDY®'s equipment grounding conductors shall follow this rule so that the fault currents can be safely carried to ground. The Type YGA and Type YGHA HYLUG™ can be used for this connection to busbar: they are UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements.



Type YGA HYLUG™



Type YGHA HYLUG™

Article 250 • Grounding and Bonding

Section 250.130(C) – Equipment Grounding Conductor Connections.

(C) Nongrounding Receptacle Replacement or Branch Circuit Extensions. The equipment grounding conductor of a grounding-type receptacle or a branch-circuit extension shall be permitted to be connected to any of the following:

- (1) Any accessible point on the grounding electrode system as described in 250.50
- (2) Any accessible point on the grounding electrode conductor
- (3) The equipment grounding terminal bar within the enclosure where the branch circuit for the receptacle or branch circuit originates
- (4) An equipment grounding conductor that is part of another branch circuit that originates from the enclosure where the branch circuit for the receptacle or branch circuit originates
- (5) For grounded systems, the grounded service conductor within the service equipment enclosure
- (6) For ungrounded systems, the grounding terminal bar within the service equipment enclosure

RACO® Boxes

This clause describes the rules for connecting the equipment grounding conductor of a grounding-type receptacle or a branch-circuit extension. RACO® Boxes can be used as grounding receptacles. They are UL listed Metallic Outlet Boxes per UL514A requirements.



RACO® Box

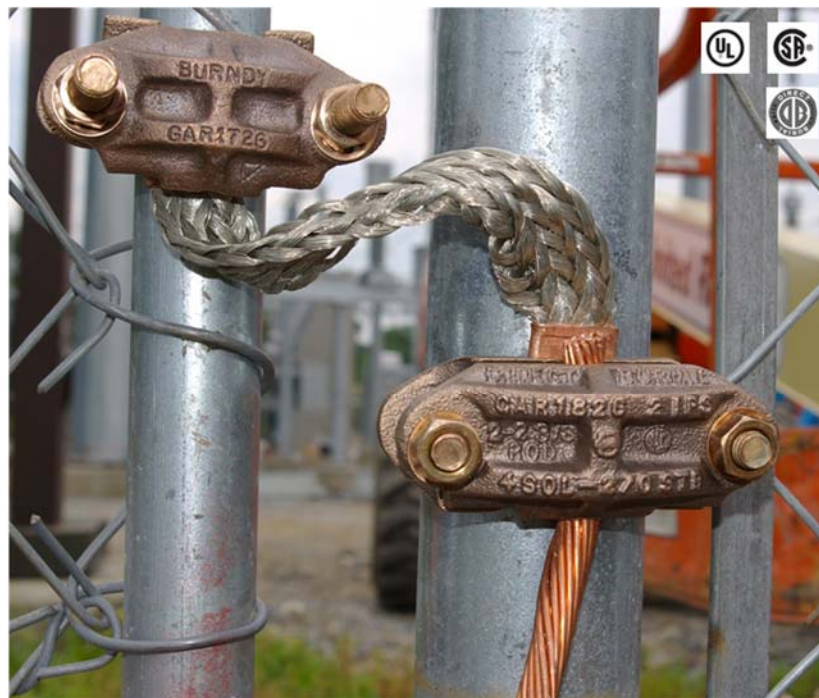
Article 250 • Grounding and Bonding

Section 250.194 – Grounding and Bonding of Fences and Other Metal Structures

Metallic fences enclosing, and other metal structures in or surrounding, a substation with exposed electrical conductors and equipment shall be grounded and bonded to limit step, touch, and transfer voltages.

BURNDY® Type GAR Mechanical Connector

The rule's purpose is to protect equipment and personnel. BURNDY®'s Type GAR Mechanical Connector is an appropriate choice. It can be used for a variety of applications, including fence post grounding, and it is also UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements. It can be installed with a calibrated torque wrench.



Type GAR Mechanical Connector

Section 300.5(E) - Underground Installations

(E) Splices and Taps. Direct-buried conductors or cables shall be permitted to be spliced or tapped without the use of splice boxes. The splices or taps shall be made in accordance with 110.14(B).^[1]

BURNDY® UNITAP™

According to this clause, direct-buried conductors or cables can be spliced or tapped without the use of splice boxes. The BURNDY® direct burial UNITAP™ connectors can be used for this application. They are UL listed & CSA certified Sealed Wire Connector Systems per UL486D & CSA C22.2 No. 198.2 requirements. The UNITAP™ connectors are suitable for wet or damp locations, and conductor ports are pre-installed with oxide inhibitor that prevents moisture/contaminants from entering the contact area.



THE MOLE™

Notes:

1. Section 110.14(B) describes requirements for splices.

Section 300.6(B) - Protection Against Corrosion and Deterioration

(B) Aluminum Metal Equipment. Aluminum raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, elbows, couplings, nipples, fittings, supports, and support hardware embedded or encased in concrete or in direct contact with the earth shall be provided with supplementary corrosion protection.

BURNDY® Types PENETROX™ A, A-13 and HT

According to this clause, aluminum metal equipment shall be suitably protected against corrosion. BURNDY®'s Types PENETROX™ A and A-13 are oxide-inhibiting joint compounds that are recommended for aluminum to aluminum, aluminum to copper connections plus aluminum conduit threads. They are UL listed Conductor Termination Compounds per UL546 requirements.^[1] BURNDY®'s Type PENETROX™ HT is an oxide-inhibiting joint compound that is recommended for aluminum to aluminum connections. It is compatible with rubber and designed for use with High Temperature ACSS and ACCC connectors.



Type PENETROX™ A



Type PENETROX™ A-13

Notes:

1. The Type PENETROX™ A is only UL listed to 600V. The Type PENETROX™ A-13 is UL listed for all voltages.

Section 300.22 - Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums)

The provisions of this section shall apply to the installation and uses of electrical wiring and equipment in ducts used for dust, loose stock, or vapor removal; ducts specifically fabricated for environmental air; and other spaces used for environmental air (plenums).

(A) Ducts for Dust, Loose Stock, or Vapor Removal. No wiring systems of any type shall be installed in ducts used to transport dust, loose stock, or flammable vapors. No wiring system of any type shall be installed in any duct, or shaft containing only such ducts, used for vapor removal or for ventilation of commercial-type cooking equipment.

(B) Ducts Specifically Fabricated for Environmental Air. Equipment, devices, and the wiring methods specified in this section shall be permitted within such ducts only if necessary for the direct action upon, or sensing of, the contained air. Where equipment or devices are installed and illumination is necessary to facilitate maintenance and repair, enclosed gasketed-type luminaires shall be permitted. Only wiring methods consisting of Type MI cable without an overall nonmetallic covering, Type MC cable employing a smooth or corrugated impervious metal sheath without an overall nonmetallic covering, electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, or rigid metal conduit without an overall nonmetallic covering shall be installed in ducts specifically fabricated to transport environmental air. Flexible metal conduit shall be permitted, in lengths not to exceed 1.2 m (4 ft), to connect physically adjustable equipment and devices permitted to be in these fabricated ducts. The connectors used with flexible metal conduit shall effectively close any openings in the connection.

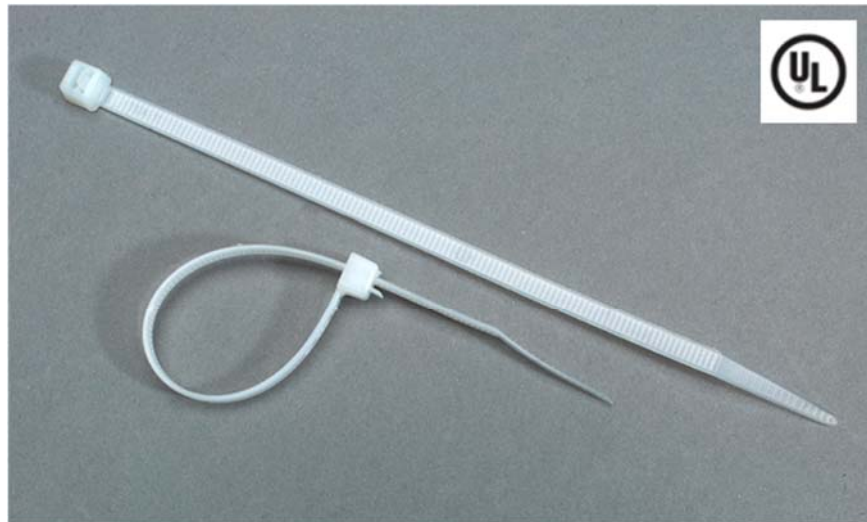
(C) Other Spaces Used for Environmental Air (Plenums). This section shall apply to spaces not specifically fabricated for environmental air-handling purposes but used for air-handling purposes as a plenum. This section shall not apply to habitable rooms or areas of buildings, the prime purpose of which is not air handling. “*Exception*” describes a situation where this requirement does not apply.

(D) Information Technology Equipment. Electrical wiring in air-handling areas beneath raised floors for information technology equipment shall be permitted in accordance with Article 645.

Section 300.22 - Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums)

BURNDY® UNIRAP™ Standard Cable Ties

The BURNDY® UNIRAP™ Standard Cable Ties provide security and support for the wiring systems described in this clause. They are UL listed Positioning Devices – Components per UL62275 requirements. BURNDY® UNIRAP™ Standard Cable Ties are also available as black or natural nylon 6/6 materials: for strength, adjustability and chemical resistance to solvents, oils, grease, and diluted acid.



UNIRAP™ Standard Cable Ties

Article 392 • Cable Trays

Section 392.60(A) – Grounding and Bonding

(A) Metallic Cable Trays. Metallic cable trays shall be permitted to be used as equipment grounding conductors where continuous maintenance and supervision ensure that qualified persons service the installed cable tray system and the cable tray complies with provisions of this section. Metallic cable trays that support electrical conductors shall be grounded as required for conductor enclosures in accordance with 250.96^[1] and Part IV of Article 250^[2]. Metal cable trays containing only non-power conductors shall be electrically continuous through approved connections or the use of a bonding jumper.

BURNDY® Type CCY Jumper

This clause describes rules for grounding and bonding of metallic cable trays. It is essential that metallic cable trays comply with this section so that the fault currents can be safely carried to ground. BURNDY® Type CCY Jumpers can be used to connect metal cable trays, providing continuity for the system.



Type CCY Jumper

Notes:

1. Section 250.96 describes requirements for “Bonding Other Enclosures”.
2. Part IV of Article 250 describes requirements for “Enclosure, Raceway, and Service Cable Connections”.

Article 392 • Cable Trays

Section 392.60(B) – Grounding and Bonding

(B) Steel or Aluminum Cable Tray Systems. Steel or aluminum cable tray systems shall be permitted to be used as equipment grounding conductors, provided all the following requirements are met:

- (1) The cable tray sections and fittings are identified as an equipment grounding conductor.
- (2) The minimum cross-sectional area of cable trays conform to the requirements in Table 392.60(A).
- (3) All cable tray sections and fittings are legibly and durably marked to show the cross-sectional area of metal in channel cable trays, or cable trays of one-piece construction, and the total cross-sectional area of both side rails for ladder or trough cable trays.
- (4) Cable tray sections, fittings, and connected raceways are bonded in accordance with 250.96^[1], using bolted mechanical connectors or bonding jumpers sized and installed in accordance with 250.102^[2].

BURNDY® Type GC-CT Cabletray Ground Clamp

This section describes the rules for using steel/aluminum cable tray systems as equipment grounding conductors. BURNDY®'s Type GC-CT Cabletray Ground Clamp is an appropriate mechanical connector for cable tray sections. It is installed with a calibrated torque wrench. It is UL listed & CSA certified Grounding and Bonding Equipment per UL467 & CSA C22.2 No. 41 requirements and suitable for direct burial in concrete or earth.



Type GC-CT Cabletray Ground Clamp

Notes:

1. Section 250.96 describes requirements for “Bonding Other Enclosures”.
2. Section 250.102 describes requirements for “Bonding Conductors and Jumpers”.

Article 392 • Cable Trays

Section 392.60(C) – Grounding and Bonding

(C) Transitions. Where metallic cable tray systems are mechanically discontinuous, as permitted in 392.18(A)^[1], a bonding jumper sized in accordance with 250.102^[2] shall connect the two sections of the cable tray, or the cable tray and the raceway or equipment. Bonding shall be in accordance with 250.96^[3].

BURNDY® Type CCY Jumper

This clause describes the proper connection for mechanically discontinuous metallic cable tray systems. It is essential that metallic cable trays comply with this section so that the fault currents can be safely carried to ground. BURNDY®'s Type CCY Jumper is an appropriate mechanical connector for cable tray sections.



Type CCY Jumper

Notes:

1. Section 392.18(A) describes requirements for “Cable Tray Installation”.
2. Section 250.102 describes requirements for “Bonding Conductors and Jumpers”.
3. Section 250.96 describes requirements for “Bonding Other Enclosures”.

Section 516.4(F) – Wiring and Equipment in Class I Locations

(F) Static Electric Discharges.

- (1) All persons and all electrically conductive objects, including any metal parts of the process equipment or apparatus, containers of material, exhaust ducts, and piping systems that convey flammable or combustible liquids, shall be electrically grounded. [34:6.8.1]
- (2) Provision shall be made to dissipate static electric charges from all nonconductive substrates in printing processes.

BURNDY® Static Electric Discharge Products

According to this section, electrically conductive objects need to be electrically grounded in order for static electric discharge to occur. This rule is intended to protect both equipment and personnel; BURNDY®'s static discharge line of products can fulfill this requirement. The Type GIE-G ground connectors are suitable for vehicle grounding and heavy duty construction. BURNDY®'s Static Discharge Reels are proudly made in the USA and provide automatic E-Z PULL rewinding.



Type GIE-G Ground Connector



Static Discharge Reel



Type GIE-G Ground Connector

Section 680.26(C) – Equipotential Bonding

(C) Pool Water. Where none of the bonded parts is in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm² (9 in.²) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

BURNDY® Pool Water Bonding Kit

The purpose of this rule is to ensure the safety of pool users. BURNDY® offers the BWB680 Series to comply with this requirement. The water bonding kit is made of non-corrosive stainless steel. It is easily installed in the skimmer so that it maintains contact with the pool water at all times and is not exposed to physical damage from pool activities. The BURNDY® Pool Water Bonding Kit is UL listed Swimming Pool and Spa Equipment per UL1563 requirements.



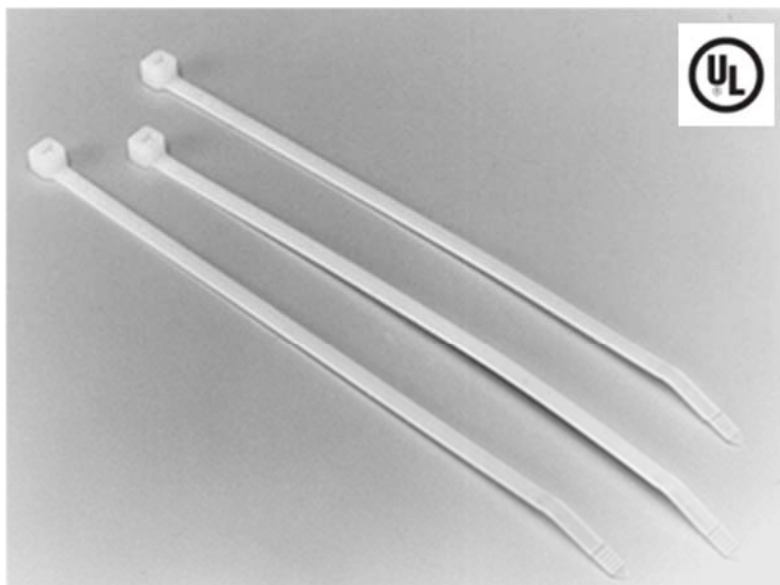
Pool Water Bonding Kit

Section 800.24 - Mechanical Execution of Work

Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be secured by hardware, including straps, staples, cable ties, hangers, or similar fittings designed and installed so as not to damage the cable. The installation shall also conform to 300.4(D)^[1] and 300.11^[2]. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

BURNDY® UNIRAP™ Standard Cable Ties

According to this clause, cables shall be secured and supported by hardware. The BURNDY® UNIRAP™ Standard Cable Ties can be used for this application. They are UL listed Positioning Devices – Components per UL62275 requirements. BURNDY® UNIRAP™ Standard Cable Ties are also available as black or natural nylon 6/6 materials: for strength, adjustability and chemical resistance to solvents, oils, grease, and diluted acid.



UNIRAP™ Standard Cable Ties

Notes:

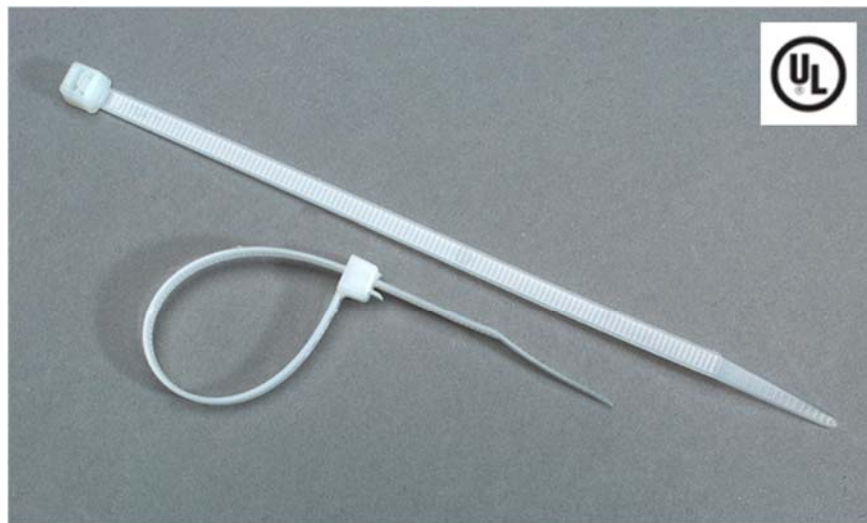
1. Section 300.4(D) describes requirements for “Cables and Raceways Parallel to Framing Members and Furring Strips”.
2. Section 300.11 describes requirements for “Securing and Supporting”.

Section 830.24 - Mechanical Execution of Work

Network-powered broadband communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be secured by hardware including straps, staples, cable ties, hangers, or similar fittings designed and installed so as not to damage the cable. The installation shall also conform to 300.11. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

BURNDY® UNIRAP™ Standard Cable Ties

According to this clause, cables shall be secured and supported by hardware. The BURNDY® UNIRAP™ Standard Cable Ties can be used for this application. They are UL listed Positioning Devices – Components per UL62275 requirements. BURNDY® UNIRAP™ Standard Cable Ties are also available as black or natural nylon 6/6 materials: for strength, adjustability and chemical resistance to solvents, oils, grease, and diluted acid.



UNIRAP™ Standard Cable Ties

Notes:

1. Section 300.11 describes requirements for “Securing and Supporting”.

Typical Grounding Questions & Answers

Q1: Why is a UL Direct Burial (DB) rating needed?

A: A UL Direct Burial rating is required in order for the connector to be buried in earth or concrete. This rating ensures that the connector will be resistant to corrosion.

Q2: How is a UL Direct Burial rating obtained?

A: The UL Direct Burial rating is obtained when a connector is UL Listed for Grounding and Bonding (UL467) and is made of any combination of copper alloy (greater than 80% content), silicon bronze and stainless steel and marked/labeled with DB or Direct Burial.

Q3: What is the difference between a ground connection and a bond connection?

A: Ground: A connection that is made directly into earth (ground rod to earth, for example).
Bond: Any connection that is made directly or indirectly to a ground rod (ground conductor to ground rod). A bonding connection completes the permanent joining of metal parts to form a reliable electrically conductive, low-impedance path for fault current.

Q4: Are there hardware kits available?

A: BURNDY® offers many kits for grounding and power applications, most of which include the connector's appropriate mounting hardware. New kits that are not yet offered can be created through BURNDY®'s Focus process. An example is the Terminal Mounting Hardware (TMH) Kit family in Section D of the BURNDY® Master Catalog.

Q5: How is a good exothermic connection tested?

A:

1. Inspection of the cross-section visually or by X-ray
2. Taking a resistance measurement through the connection
3. Hammer Test

Q6: When is PENETROX™ required for a grounding connection?

A: When the connector's material and the mounting structure's material differ, the use of PENETROX™ maintains the electrical connection, increases corrosion resistance and helps prevent contaminants from entering the connection.

Q7: What is the fault current rating for a connector?

A: The fault current rating is the amount of current that a connector can withstand for a specified amount of time. These values are determined by the wire size and can be found in the Industry Standard for which the connector is rated. BURNDY® grounding connectors are rated for the fault current of the maximum conductor accommodated by that connector.

National Electrical Code® Requirements and BURNDY® Products Handbook

Q8: Where are proper connector torque values in the National Electrical Code®?

A: Informative Annex I – Recommended Tightening Torque tables from UL Standard 486A-486B

Q9: How can a fence gate around a substation be grounded and bonded to comply with the NESC® and the National Electrical Code®?

A: According to Section 250.194, metallic fences enclosing a substation shall be grounded and bonded. BURNDY®'s Type GAR Mechanical Connector is an appropriate choice for this application along with flexible braid at the hinge points of gates. BURNDY® SERVIT® Split Bolt connectors are commonly used to bond barbed wire and chain-link fences mesh to a down lead conductor. thermOweld® also has the flexible gate jumpers, which can be connected to fence gate via exothermic welding or compression.

Q10: When shall bonding jumpers be used on cable trays? What size shall be used? Can bonding jumpers be used on steel and aluminum? Where is this referenced in the National Electrical Code®?

A: Bonding jumpers shall be used on cable trays as specified in Section 392.60.

Q11: What connectors are available for bonding cable tray to building steel and where in the National Electrical Code® does it require this bonding?

A: The GC-CT series connector was designed and tested specifically for bonding to cable tray: both steel and aluminum. The new code requirements to treat building steel as an electrode mean that as the tray passes close to a structural steel beam it must be bonded to that steel. Conduit Hangers, Strut Hangers and other such mechanical devices are not listed for grounding and bonding. The YGIB can be used to bond to the steel and a jumper to a GC-CT would be required. Also, the new BGBS lay in lugs will meet the requirement for both the steel beam and the cable tray connection.

Q12: Is it a requirement to bond building steel to the equipment grounding conductor? How can this be done? Where is this in the code?

A: According to Section 250.50, building steel shall be bonded to the equipment grounding conductor. The building steel is connected to the equipment grounding conductor as specified in Section 250.52(A)(2). If the steel beams are drilled in the web area, then BURNDY®'s Type GB, Type GC, and Type KC connectors can be used for this connection.

National Electrical Code® Requirements and BURNDY® Products Handbook

Q13: How can foundation pad and rebar be used as a ground electrode and where is that in the code?

A: Foundation pad and rebar can be used as a ground electrode as specified in Section 250.52(A)(3). BURNDY®'s HYGROUND®, thermOweld®, and other mechanical connectors can be used for bonding to rebar if they are listed for direct burial in concrete.

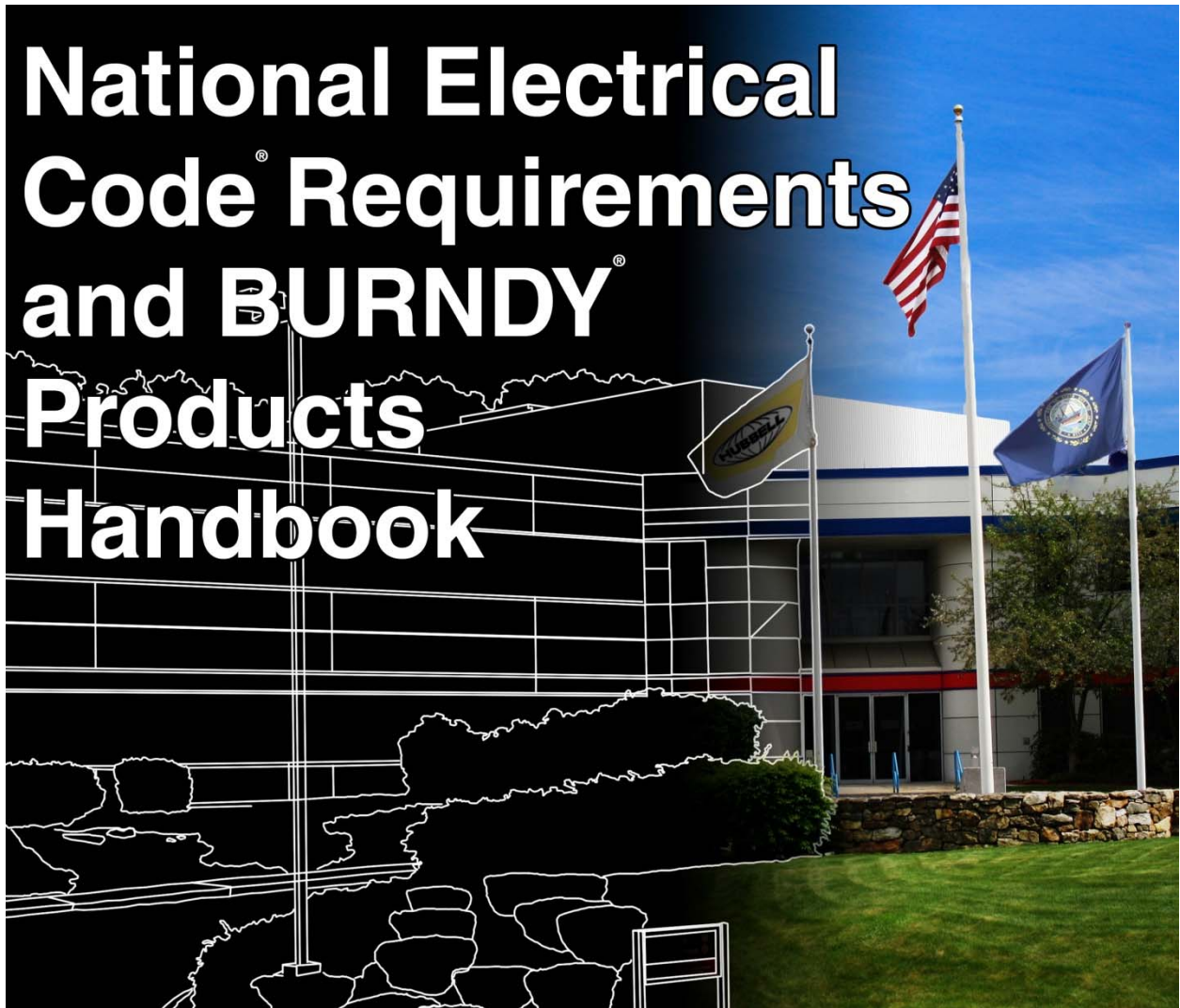
Q14: Where in the code does it require the use of a torque wrench or torque screwdriver for all mechanical electrical connectors?

A: Section 110.14(D) – Electrical Connections as of 2017. As each State adopts the new National Electrical Code®, it will become law. It has been an informational note in 110.14 in previous codes.

Q15: Does the National Electrical Code® cover metric wires?

A: No. According to Section 110.6 (Conductor Sizes) from Article 110 (Requirements for Electrical Installations), “Conductor sizes are expressed in American Wire Gage (AWG) or in circular mils.”

National Electrical Code[®] Requirements and BURNDY[®] Products Handbook



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