

2018 CANADIAN ELECTRICAL CODE

SUBJECT: Section 10 – Grounding and bonding

Rule 10-102 Grounding electrodes

Replacing metal water service lines with non-metal type

The replacement of existing metal water service lines with a non-metal type and the insertion of non-metal devices such as water softeners in the water line may result in a loss of adequate service grounding.

To ensure that grounding is not compromised:

- a) Where a metal water service line serving as the grounding electrode is replaced with a non-metal line, an alternate ground electrode should be installed.
- b) Where non-metal devices are inserted into a water line serving as the grounding conductor, a grounding jumper sized in accordance with Rule 10-114 should be installed.

When utilizing a metal water pipe as an electrode, connection as per Rule 10-118 should be made on the street side of the water meter and as close as practicable to the point of entrance of the water service.

Plate Electrode

Rule 10-102 2) c) requires that a plate electrode be buried at least 600 mm below finished grade level. Safety Codes Officers have encountered situations where plate electrodes have been placed just below the concrete slab in basements, apparently due to a misunderstanding of the term “finished grade level”.

Finished grade level is interpreted as the anticipated final elevation of the surface directly above the plate electrode.

Plate electrodes in basements should be buried at least 600mm below the expected final surface elevation of the basement floor.

Note: see end of this STANDATA for information on Grounding and Bonding at Oil and Gas Drilling or Servicing Operations

Rule 10-210 Grounding connections for solidly grounded ac systems supplied by the supply authority

Installation of Grounded Service Conductor

The bonding conductor in a cable assembly is intended to be used as an equipment-bonding conductor. Where armoured cables are installed as consumer's service conductors in

Unless stated otherwise, all Code references in this STANDATA are to the Canadian Electrical Code, Part I, 2018.

Issue of this STANDATA is authorized by
the Provincial Electrical Administrator

[Original Signed]

Clarence C. Cormier, P.Eng.

The logo for the Province of Alberta, featuring the word "Alberta" in a stylized, cursive font with a small blue square to the right of the letter "a".

compliance with Rule 6-302, the bonding conductor does not necessarily meet the minimum size requirements of Rule 10-114 and it may be necessary to use a 4-conductor cable.

Elimination of stray voltage in areas housing livestock

Where stray voltages are severe enough to present a problem in facilities housing livestock, neutral to earth reactors (commonly known as "tingle voltage filters") are permitted by Rule 10-116 2).

Neutral to earth reactors should not be used until it has been determined that improperly installed, or improperly maintained electrical systems or equipment have been corrected to eliminate them as a possible cause of the stray voltage problems.

Rule 10-212 Grounding connections for solidly grounded separately derived ac systems

Circuits supplied from two sources

Where circuits are supplied from two sources, certain grounding arrangements may affect the operation of ground fault sensing devices. Following are some guidelines for effectively grounding two sources supplying circuits through a transfer switch or tie.

Grounding at both sources of supply

Where two ground electrodes are used, one for each source of supply (e.g., utility power and power from a standby or emergency generator), it would be good design practice to isolate the grounded circuit conductor for each system through an extra pole at the transfer switch. This arrangement would reduce the potential for nuisance tripping of ground-fault sensing equipment.

Grounding at a single point

Subrule 1) a) iii) permits a single connection to a grounding conductor to be connected to the tie point of the grounded circuit conductors in the transfer switch or at the service equipment.

Rule 10-214 Grounding connections for portable generator assemblies and vehicle-mounted or mobile generators

Neutral Connections

Portable generators are being used more and more by homeowners as back-up or stand-by power and it is important that the electrical system is properly grounded. Generators are available with the neutral bonded to the frame or without (floating neutral). The following is recommended:

Neutral Bonded to Frame

If the generator has a neutral bonded to the frame, the neutral should also be grounded to a grounding electrode and the transfer switch should have an extra pole to switch the neutral. Switching the neutral will ensure that at any given time the neutral is only grounded at one point (either the main switch or the generator).

Floating Neutral

If the generator has a floating neutral, it should not be grounded to a grounding electrode nor should it be switched in the transfer switch. The generator frame is bonded to ground as a result of the "equipment bonding" requirements of the Code and the neutral connection to the electrode is maintained at the main service via a solid neutral connection in the transfer switch.

Because of the variety of emergency and standby power systems, it is not always feasible to provide fixed recommended practices. Each installation should be evaluated and designed to satisfy specific load, customer and code requirements. Furthermore, in situations where it may be necessary to remove bonding screws or jumpers in the service switch or at the generator, you should follow manufacturers' instructions.

Bonding – General (10-500 Series)

Installation of equipment bonding conductors

- (1) The bonding conductor for equipment shall be permitted to be spliced or tapped, but such splices or taps shall be made only within boxes, except in the case of open wiring where they shall be permitted to be made externally from boxes and shall be covered with insulation.
- (2) Where more than one bonding conductor enters a box, all such conductors shall be in good electrical contact with each other by securing all bonding conductors under bonding screws, or by connecting them together with a solderless connector and connecting one conductor only to the box by a bonding screw or a bonding device, and the arrangement shall be such that the disconnection or removal of electrical equipment fed from the box will not interfere with, or interrupt, the bonding continuity.
- (3) Where a bonding conductor is run in the same raceway with other conductors of the system to which it is connected, it shall be insulated, except that where the length of the raceway does not exceed 15 m and does not contain more than the equivalent of two quarter bends, an uninsulated bonding conductor shall be permitted to be used.
- (4) Where a metal raceway or steel pipe is used as a bonding conductor, the installation shall comply with Section 12.
- (5) A copper bonding conductor shall
 - a) if No. 6 AWG or larger and attached securely to the surface on which it is carried, be protected where exposed to mechanical damage; and
 - b) if smaller than No. 6 AWG, or if the installation does not come within the provisions of Item a) of this Subrule, be installed and protected in the same manner as the circuit conductor for a given installation.
- (6) An aluminum bonding conductor shall
 - a) if No. 4 AWG or larger and attached securely to the surface on which it is carried, be protected where exposed to mechanical damage; or
 - b) if smaller than No. 4 AWG, or if the installation does not come within the provisions of Item a) of this Subrule, be installed and protected in the same manner as the circuit conductor for a given installation.
- (7) Where a separate bonding conductor is required by this Code to supplement the bonding afforded by a metal raceway, it shall be installed in the same raceway as the circuit conductors.
- (8) Where a separate bonding conductor, required by this Code, is run with single-conductor cables, the bonding conductor shall follow the same route as the cables.

Rule 10-600 Bonding for fixed electrical equipment**Rule 10-610 Bonding means – fixed equipment**Stainless steel mineral-insulated electrical-heat-trace cable bonding requirements.

It is common practice to install SS MI EHT cable, (stainless steel mineral insulated electrical heat trace cable), for Modular fabrication of piping systems, with splices between portions of cables made in the field. Where SS MI EHT cable is spliced in the field, confusion exists regarding the bonding to ground of metallic junction boxes. To assist industry in determining bonding requirements for metallic junction boxes, the following requirements are to be observed:

- Rule 10-600 1) requires that all non-current carrying parts of electrical equipment to be connected to a bonding conductor.
- Rule 10-610 outlines the acceptable means of achieving equipment bonding

In the application of these requirements, distinction must be made between:

1. stainless steel MI cable supplying power to electrical equipment
 2. stainless steel MI electrical heat tracing being supplied power as electrical equipment.
1. For SS MI cable supplying power to electrical equipment, the sheath is not considered as a suitable bonding conductor, and therefore the MI cable requires a bonding conductor incorporated within the cable.
 2. When SS MI electric heat trace cable is being supplied power as electrical equipment, the stainless steel sheath is not serving as a bonding conductor, but rather as a metallic enclosure. Therefore this stainless steel metallic sheath must be bonded as required by Rule 62-104 2).

Guidelines for field installed SS MI EHT cable splices/junctions:

1. Metallic junction boxes used in conjunction with SS MI EHT, to interconnect various sections, must be bonded to ground as required by Rule 10-600 1).
2. Fiberglass/Plastic junction boxes used in conjunction with SS MI EHT will not require a bonding conductor to the JB, however the continuity between the connectors/cable sheaths must be maintained. Bonding jumpers installed as per Rules 10-614 will be acceptable.
3. SS MI EHT male and female cold lead assemblies attached to the SS MI EHT are certified for that purpose and no additional bonding is required.

Bonding Jumpers with Flexible Conduit

The requirement to install an equipment bonding conductor within flexible conduit as described in Rule 10-610 3) may not always be practicable. Motors and other equipment may not have provision for connecting a bonding conductor within the connection box.

The following alternative is considered acceptable:

A bonding conductor meeting the requirements of Rules 10-612 and 10-614 may be secured to the exterior of flexible conduit where:

- (a) The conduit does not exceed 1.5 m in length; and
- (b) The motor or equipment is being reused or relocated in either new or existing installations; and
- (c) The equipment does not have provision for connection of the bonding conductor within the connection box.

10-612 Bonding conductor connection to electrical equipmentBonding and Pigtail Requirements for General Use Switches

Clarification is requested by industry regarding Rule 10-612 (5) that states “In the case of metal-enclosed systems where bonding is provided by the metal enclosure, and a device attached to the enclosure has a bonding terminal, a bonding conductor shall be installed to bond the device to the enclosure.”

The question is in regard to the bonding screw that is provided with the switches that are universally sold in Canada. In the United States, the bonding screw is a requirement for jurisdictions that allow plastic boxes that do not have the bonding strap in their design. It is believed that those kind of boxes are not allowed anywhere in Canada. Manufacturers have indicated that the screw is left on the Canadian product only as an option. A rewording of this rule is in the works at the CSA level but will not appear until at least the next code cycle.

It was reported that some manufacturers include bonding screws and others don't include them when shipping them to Canada. It has been clarified that as long as the switches are screwed into a metal strap, providing continuous bonding, it should be acceptable to the AHJ.

Rule 10-700 Equipotential bonding of non-electrical equipmentBonding of Gas Piping Systems

Bonding of gas piping systems should not interfere with any cathodic protection forming part of the gas piping system. The bonding of the gas line should therefore be made on the consumer side of the gas meter. Common practice in residential applications has been to bond the gas piping system to the cold water pipe at the hot-water tank. With the increasing use of plastic water lines, it is recommended that the gas piping system be bonded to the main distribution panel or the grounding conductor or the grounding electrode. When bonding soft copper propane lines and other similar tubing, care should be taken to ensure the piping is not damaged.

Grounding and bonding at oil and gas drilling or servicing operations

Rule 10-102 1) requires that grounding electrodes shall consist of a manufactured, field-assembled or in-situ type.

When setting up a service rig or a drilling rig, the use of manufactured or field-assembled electrodes as described in Rules 10-102 2) and 10-102 3) can be impractical. The following interpretation is considered acceptable for meeting the intent of an in-situ type grounding electrode:

a) The rig guyline anchor (usually the closest one to the rig generator)



b) The well casing,



For equivalency to conventional electrodes, the portion of the anchor or well casing below 600 mm from finished grade should present an equivalent surface area in contact with earth as do manufactured electrodes.

Equipotential bonding of non-electrical equipment

Although the CE Code does not specifically require that non-electrical equipment around drilling or service rig installations be bonded, the intent of Rule 10-700 is to have the metal parts of non-electrical equipment bonded to ground to prevent dangerous potentials in the event of electrical faults (see the Appendix B note to this Rule).

The nature of the activity around drilling operations (i.e., wet conditions and the potential for explosive atmospheres) is a strong factor to support the need for bonding non-electrical metal equipment to minimize shock hazards and potential static discharges.

EXAMPLES OF BONDING



Note single metal-to-metal connection



Note double metal-to-metal connection

Equipotential bonding conductor requirements

Rules 10-702 to 10-708 serves as a guideline for bonding non-electrical equipment to ground. To protect against loss of bonding, approved lugs are required for a positive connection. Due to the possibility of damage, a bonding conductor no smaller than AWG #6 copper or AWG #4 aluminum should be used.

Rule 10-706 requires that equipotential bonding connections are made secure and be suitable for the conditions to which they may be subjected. For grounding and bonding of rigs, the use of a suitably rated copper or aluminum lugs with associated buss is acceptable. Pliers-style, screw-type or spring enabled booster cable clamps are not considered acceptable as they may be easily dislodged.

It is important that the installation and connections of the grounding and bonding conductors are reliable. The connections or lugs should make good metal-to-metal contact to the non-electrical equipment being bonded. The conductors should be well secured to the connectors. In addition, Rule 10-116 of the Canadian Electrical Code requires that the grounding conductor be electrically continuous throughout its length.

Extra precautions should be taken to ensure conductors and connectors are not subject to damage that could result in a loss of continuity. Contractors should incorporate measures to prevent circumstances within operations that could result in a loss of continuity. This may include altering traffic patterns, flagging or other means of protecting the grounding and bonding conductors and their connections.

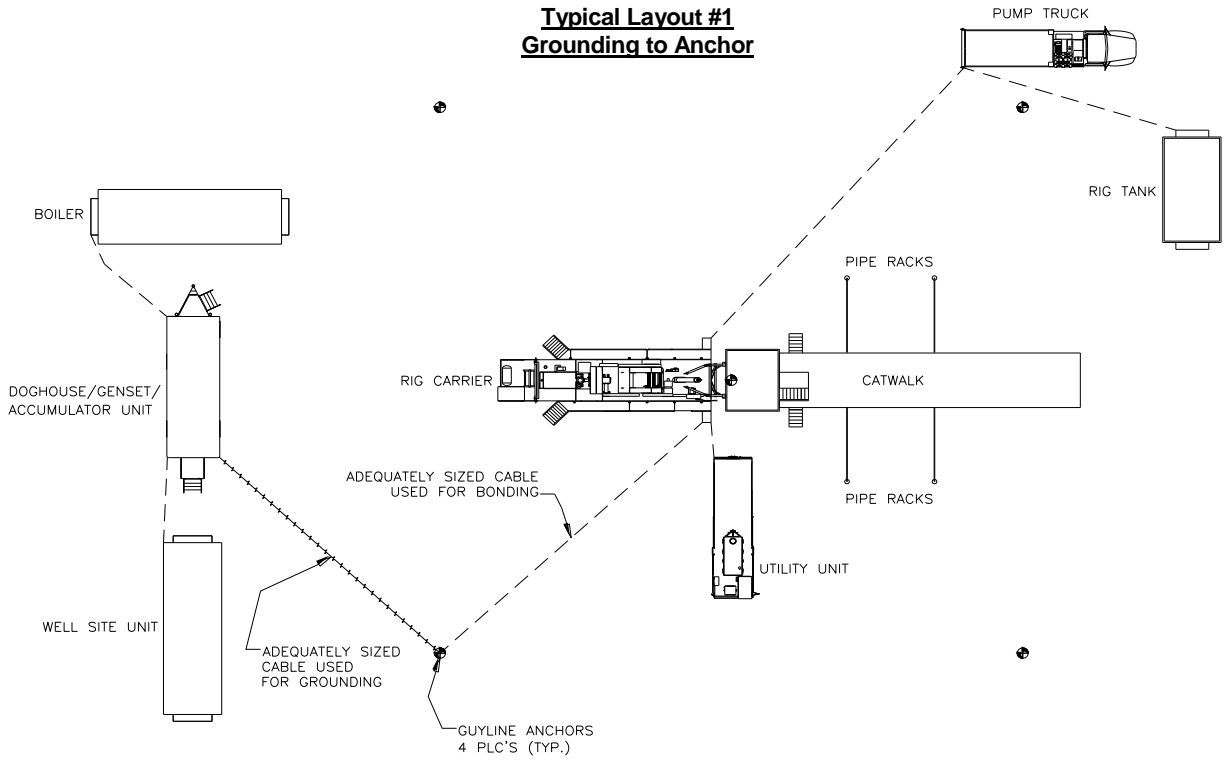
Typical grounding and bonding layout

- 1) AC system grounding conductor run to an aluminum lug or buss attached to a rig anchor or the wellhead.
- 2) The remaining “non-electrical equipment” (i.e., rig, utility skid, mud pump, mud tank, generator building, boiler, etc.) bonded to ground with:
 - a) a bonding conductor interconnecting each piece of equipment back to the ground electrode; or
 - b) a bonding conductor from each piece of equipment to the ground electrode; or
 - c) a combination of a) and b) above.

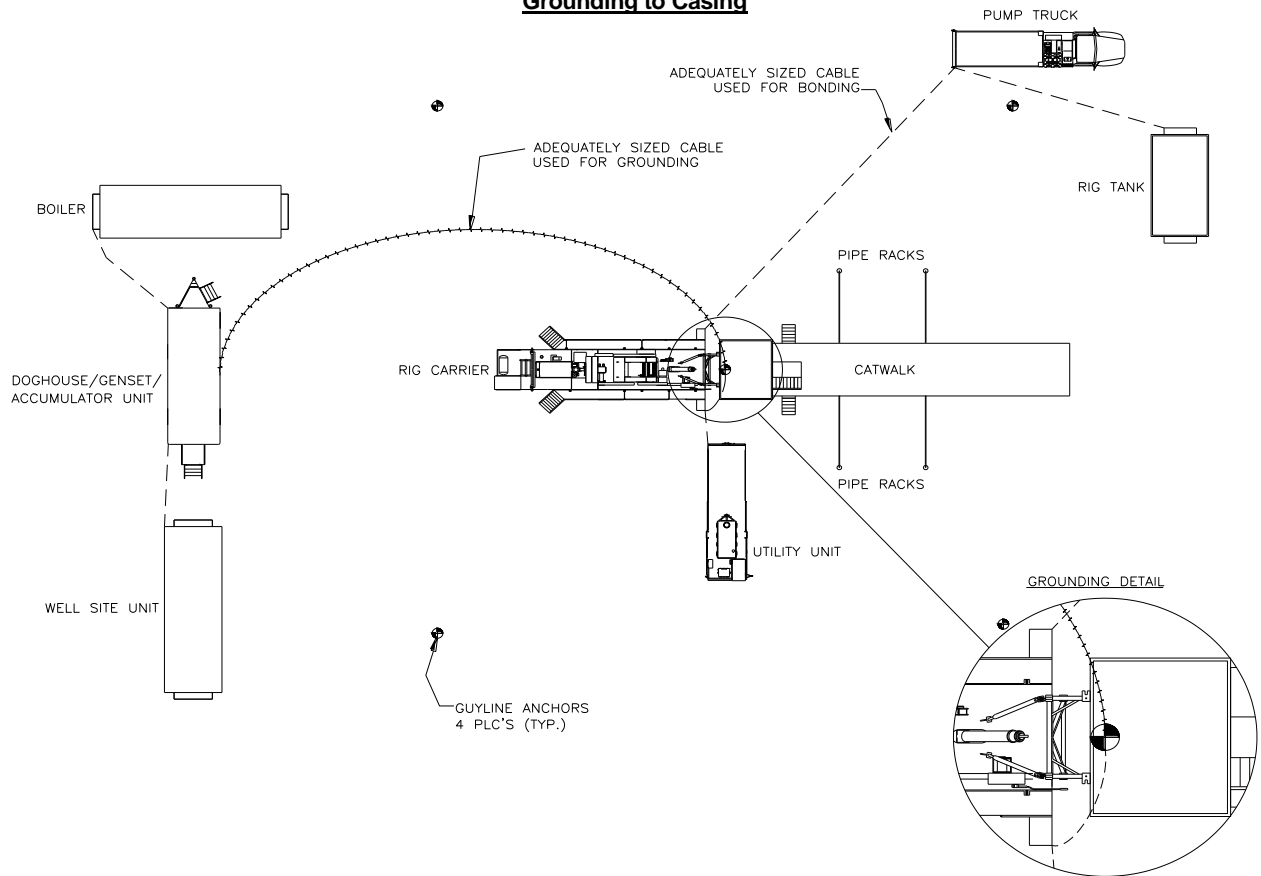
A #4 copper welding cable provides an excellent type of flexible cable for bonding purposes and AC system ground for most applications on service rigs.

Refer to the following diagrams as examples of typical rig grounding and bonding layouts.

Typical Layout #1
Grounding to Anchor



**Typical Layout #2
Grounding to Casing**



Disclaimer: The information in this bulletin is not intended to provide professional design advice. If professional expertise is required with respect to a specific issue or circumstance, the services of a professional should be sought.