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Canadian Electrical Code

SECTION 10 ONLY

Effective: January 1, 2019

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SECTION10 - GROUNDING & BONDING

10-000 - Scope

Grounding and bonding installations shall conform to the drawings provided by the Electrical Inspections department Interpretations Figures 1 to 9. The Appendix B drawings may be followed under special permission.

10-004 - Special terminology

Equipotentiality - This is a new definition introduced into the code to describe the state in which conductive parts are at a **substantially** equal electric potential

Grounding - a permanent conductive path to earth. Sometimes referred to as 'earthing' this accomplishes system stabilization and establishes an equipotential plane in the surrounding soil.

Bonding - a low impedance path obtained by joining all non-current carrying metal parts to ensure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it and to facilitate the operation of the protective (overcurrent…) device in the circuit. Also creates equipotentiality between all metallic parts.

Grounded conductor - is now defined in the code as the conductor that is intentionally grounded in a system.

System bonding jumper – is the connection between the electrical systems' grounded point (neutral) and the non-current-carrying conductive parts (metal enclosure, raceways etc.) of the electrical system to establish a solidly grounded system.

Single point system grounding - is the connection of the system neutral or grounded system conductor to a ground electrode **at one point only**. This connection shall be made as close to the source as possible.

10-100 & 10-500 - Current over grounding and bonding conductors

For the purposes of Rules 10-100 & 10-500, the term 'objectionable flow of current' shall be defined as "any current that flows over conductors for which they were not intended and/or designed to accommodate, such as neutral current over bonding and/or grounding conductors, neutral current over metallic piping". Caution shall be exercised to prevent this situation from occurring.

10-102 - Grounding electrodes

Underground metallic water lines **shall not** be used as a grounding electrode. Any existing ground connection to the water line shall be removed when upgrading the services. A tag stating **'WARNING POSSIBLE SHOCK HAZARD'** shall be installed at the water meter. Please contact your local inspector for tags as required. See **Figure 1**

Figure 1

10-108 - Lightning protection system down conductors and grounding electrodes (see Appendices B & G)

Recommended practices for the installation of a lightning protection system, including lightning rods, interconnecting conductors and ground electrodes, are given in CAN/CSA-B72. Other national and international industry-recognized standards on lightning protection may also be available.
As per Rule 12-016 where lightning down conductors are installed, electrical wiring shall, where practicable, be kept at least 2 m (6') from such conductors, and installed at or below ground level in accordance with Rule 10-104.

Note:
- Lightning protection system installations are to be installed by a licensed contractor and require an electrical permit.

10-112 - Material for grounding conductors (see Appendix B)

Bare aluminum shall not be installed in corrosive locations such as direct earth burial or masonry.

10-116(1) - Installation of grounding conductors (see Appendix B)

The grounding connection shall be **electrically continuous** throughout its length. This can be accomplished through approved split bolts, lugs, etc.

10-210 - Grounding connections for solidly grounded ac systems supplied by the supply authority (see Appendix B)

1) There shall be an electrode and grounding conductor connected to the non-current carrying parts of electrical equipment at all facilities supplied with electrical power. See **Figure 2.**

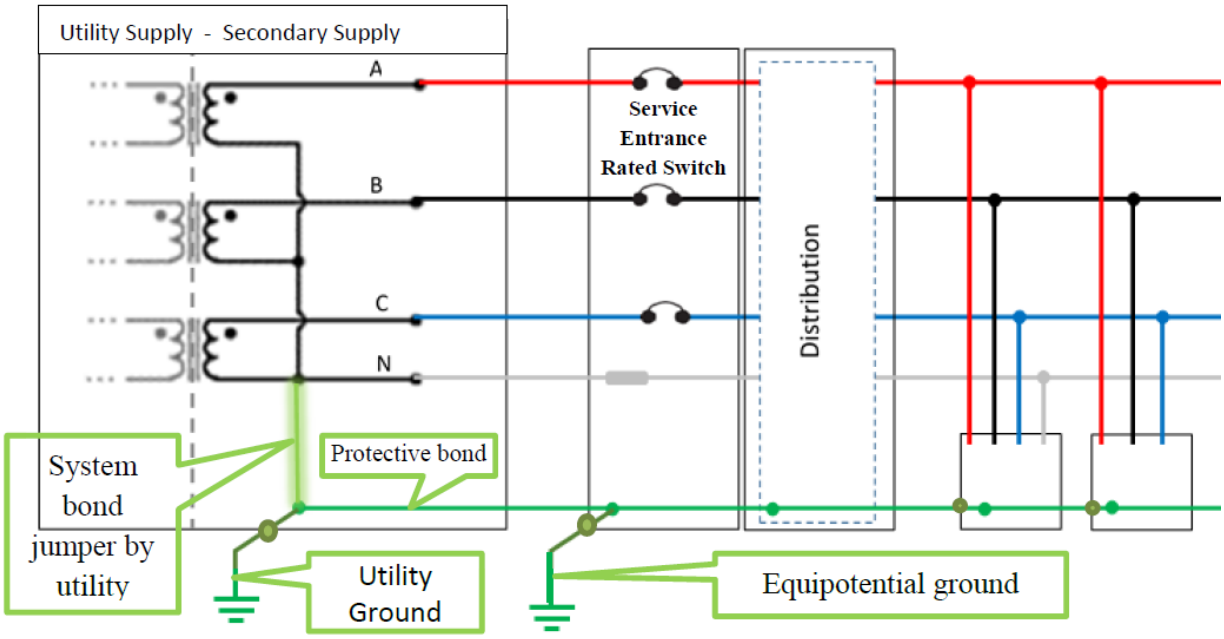
2) Customer owned service conductors supplied and installed by the electrical contractor shall include a separate neutral, where required, and bonding conductors. Service conductors supplied and installed by the supply authority (utility) may include separate neutral and bonding conductors. See **Figure 2.**
Where separate neutral and bonding conductors are installed, there shall be no need for a system bonding jumper at the facility. The neutral conductor, where required, shall be insulated and remain isolated beyond the connection to the source. See **Figure 2 & 7.**

3) Where separate neutral and bonding conductors are not installed, the neutral/grounded system conductor shall be connected to ground either directly to the facility electrode or through the system bonding jumper. This connection shall be made at the first point of attachment or connection of the supply service conductors.
This connection shall be made at only one point and the neutral conductor shall be insulated and isolated from the grounding and bonding systems, metallic equipment and metallic surfaces beyond this connection. See **Figure 4, 4a, 5, 5a, 6 & 6a.**

4) For overhead services, an insulated and weatherproof connection of the neutral conductor and bonding conductor shall be made at the overhead point of attachment where a service bonding conductor is not installed. See **Figure 4, 4a, 5 & 5a.**

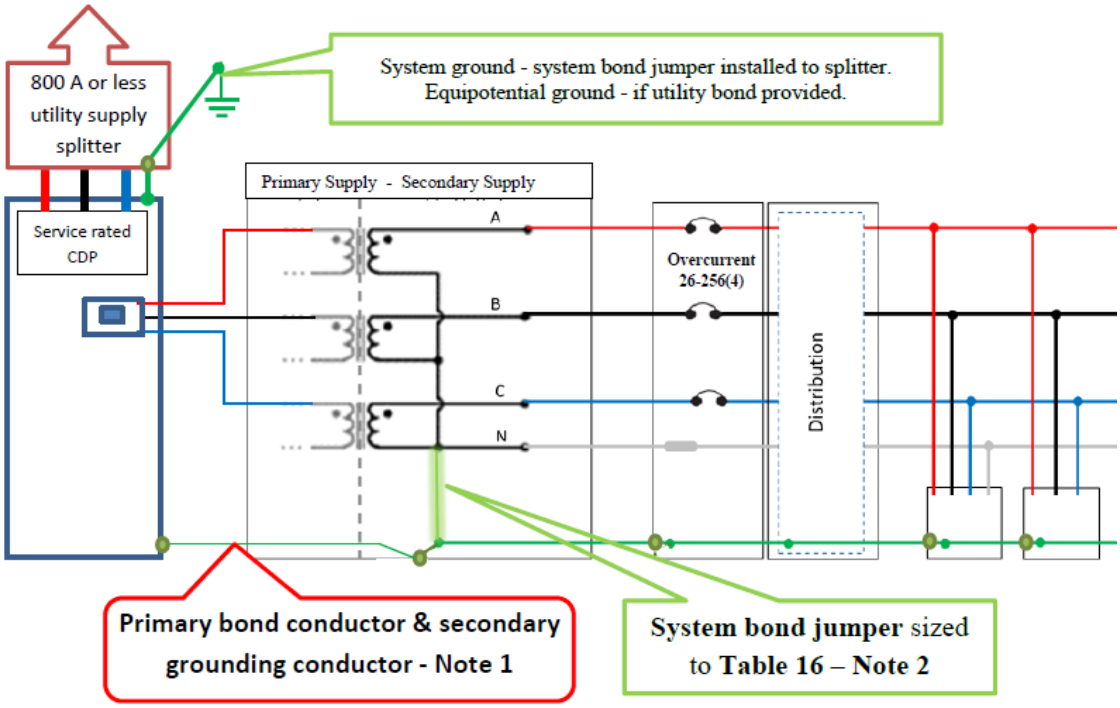
5) Where a neutral conductor is not required (there are no neutral loads being served), a bonding conductor shall be installed to facilitate the fault return. The supply authority may require a neutral conductor to satisfy the metering requirements. See **Figure 9.**

Warning – contact your local utility to determine whether they are delivering a bond and a neutral or just a neutral conductor to assist in drawing selection



Note - Utility owned transformer is grounded and the system bond jumper is installed in accordance with utility standard, the protective bond is sized as per Table 16 based on the ungrounded conductor ampacity per 10-614(2) and is carried with the main conductors to the service entrance switch. All other equipment grounding is for the purpose of establishing an equipotential plane.

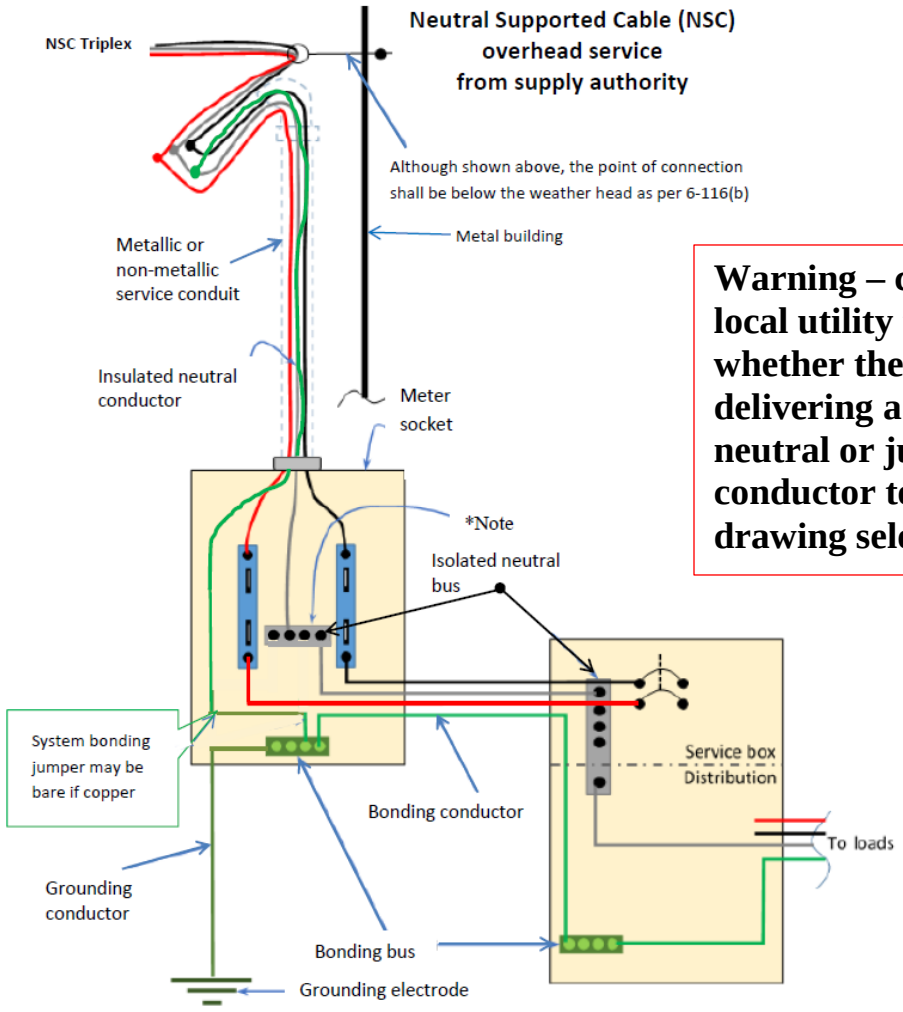
Figure 2



Note 1 – The bond conductor run with the primary feeder for a separately derived system is sized sufficiently to also function as the secondary ground per 10-212(2).

Note 2- The system bond jumper per 10-614 must be sized to the secondary of the transformer based on the current from primary overcurrent device rating multiplied by the primary to secondary voltage ratio.

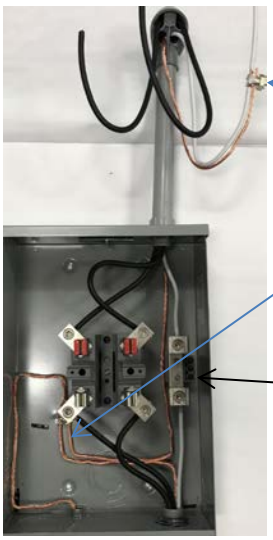
Figure 3



Warning – contact your local utility to determine whether they are delivering a bond and a neutral or just a neutral conductor to assist in drawing selection

Note – This wiring method shall be used when an isolated neutral is available for the meter socket. See **Figure 4a** for an alternative

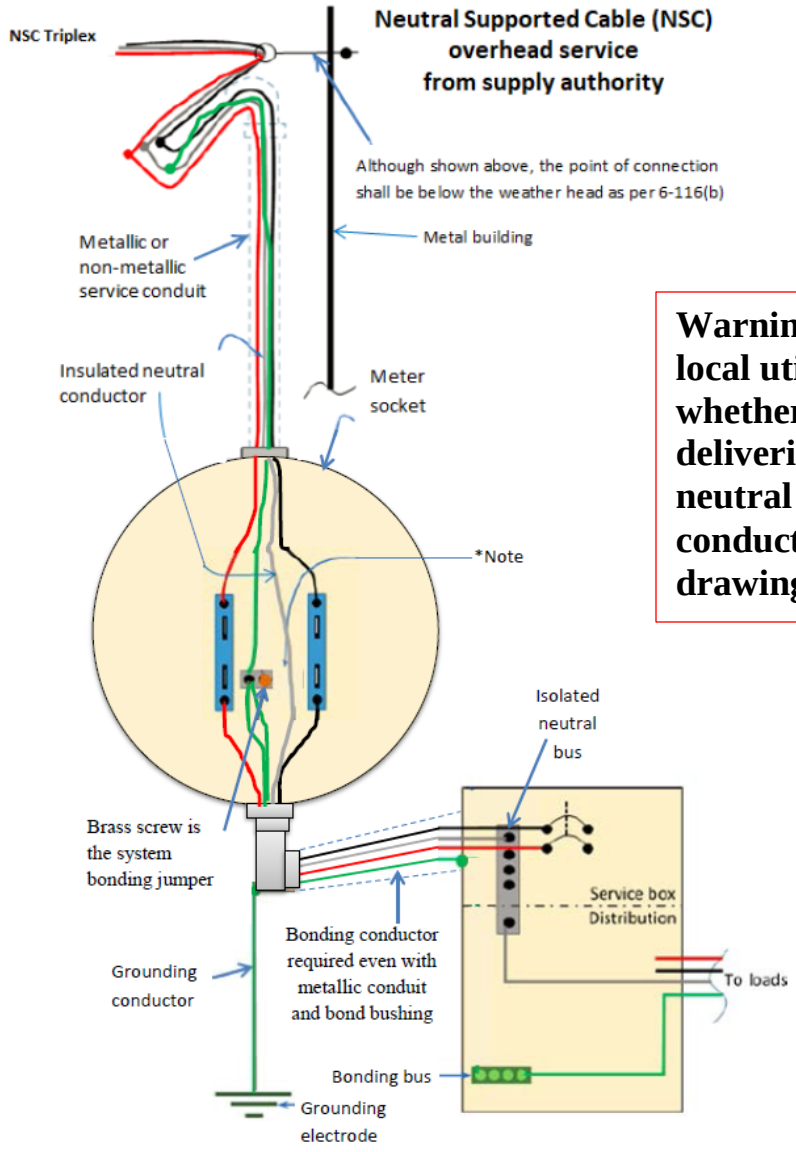
Figure 4



NOTE: This installation has an isolated neutral bus installed in the meter socket. This may be an older square 100A socket or a newer style meter socket. The ground electrode connection is in the socket and has the system bonding jumper installed to and connected at the mast. See 10-102.

Neutral is on an isolated bus.

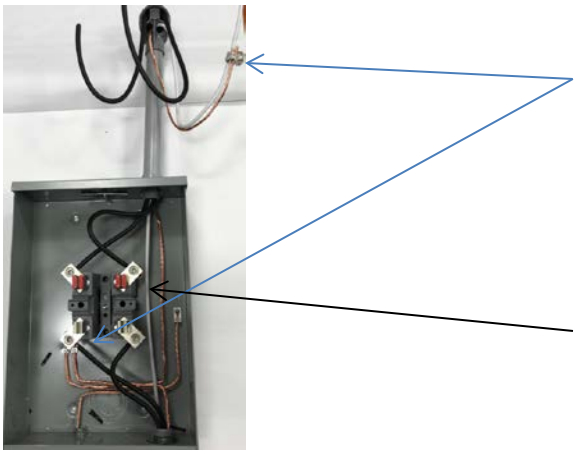
Figure 4a



Warning – contact your local utility to determine whether they are delivering a bond and a neutral or just a neutral conductor to assist in drawing selection

Note – When an older style meter socket is used or reused without the isolated neutral, this method may be used for overhead. See 10-102.

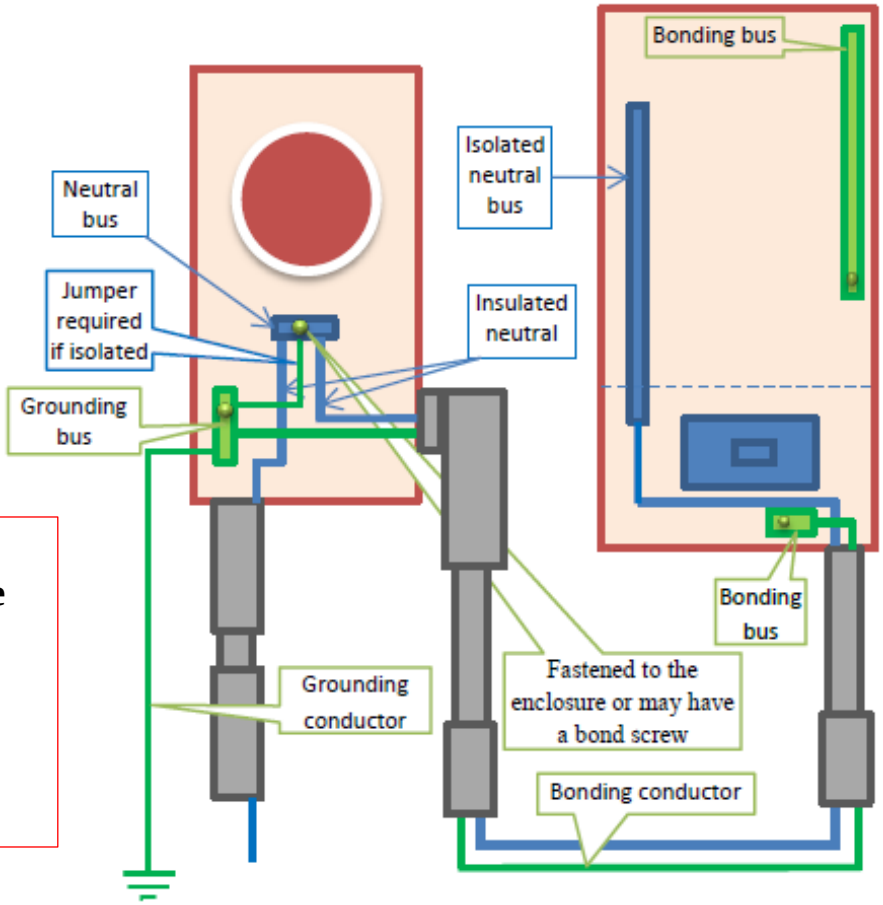
Figure 5



NOTE: This installation has no isolated neutral bus in the meter socket like the small round 100A sockets. The ground electrode connection may be in the socket or the panelboard and has the system bonding jumper installed to and connected at the mast. See 10-102.

Neutral runs through meter socket unbroken.

Figure 5a



Warning – contact your local utility to determine whether they are delivering a bond and a neutral or just a neutral conductor to assist in drawing selection

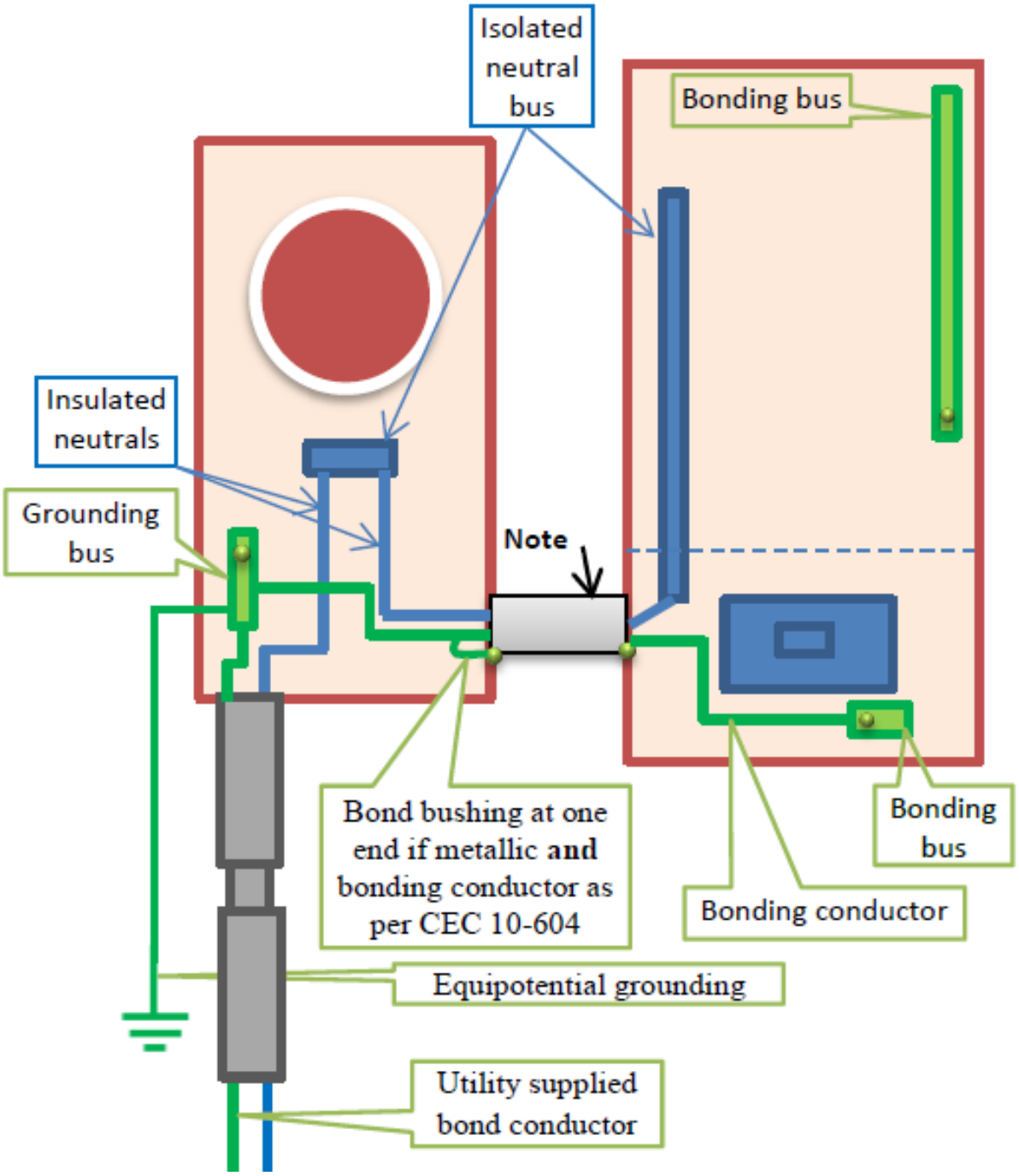
Note – This is the current method when the utility does not supply an underground bond conductor. The neutral is re-grounded at the customer meter and isolated beyond that point.

Figure 6

NOTE: This installation has an isolated neutral bus in the meter socket and has the system bonding jumper installed. When the utility cable includes a bonding conductor, this jumper can then be removed by the utility installer or contractor.

Install the system bonding jumper if you do not know what the utility will be supplying, a neutral and a bond or just a neutral.

Figure 6a



This is the new method to use when the utility supplies an underground bond conductor. The neutral conductor and busing is isolated from all metallic surfaces beyond the utility. See Figure 6a with the system bonding jumper removed. Note – Any metallic service raceways shall have a bond bushing which may be installed at either end and be supplemented with a bonding conductor sized to Table 16.

Figure 7

Warning – contact your local utility to determine whether they are delivering a bond and a neutral or just a neutral conductor to assist in drawing selection

10-212(2) - Grounding connections for solidly grounded separately derived systems

The bonding conductor in the primary feed to a transformer enclosure will meet the requirements of the grounding conductor for the X_0 on the secondary side of the transformer.

The system bonding jumper (see 10-004 & 10-614) shall be sized as per Table 16 based on the secondary current of the transformer which is determined by the primary overcurrent protection device rating multiplied by the primary to secondary voltage ratio and connected to the enclosure to satisfy the requirement for the secondary fault return current and the grounding requirement.
See **Figure 3** and the **3 Phase Dry Core Transformer Tables.**

10-302(2)&(3) - Use (see Appendix B) – Impedance grounded system

Impedance grounded systems require the grounding circuit to be electrically continuous and monitored. This includes the connections from the X_0 through the impedance device and the impedance system bonding jumper to the grounding conductor connection.

The integrity of the impedance grounding system shall be monitored with an audible or visual alarm, shall be visible to persons monitoring the status of the system and labeled:
'CONTACT _____ IF THE SYSTEM IS IN ALARM'.

10-308 - Conductors used with impedance grounding devices (see Appendix B)

Where the system is not serving neutral loads, the conductor connecting the impedance grounding device to the neutral point of the system source shall meet the requirements of this Rule and shall not be installed to the main switchgear, unless otherwise required for metering purposes or installation to the impedance grounding device. This neutral shall not be distributed and shall be labelled at each termination point to indicate "NOT FOR NEUTRAL LOADS".

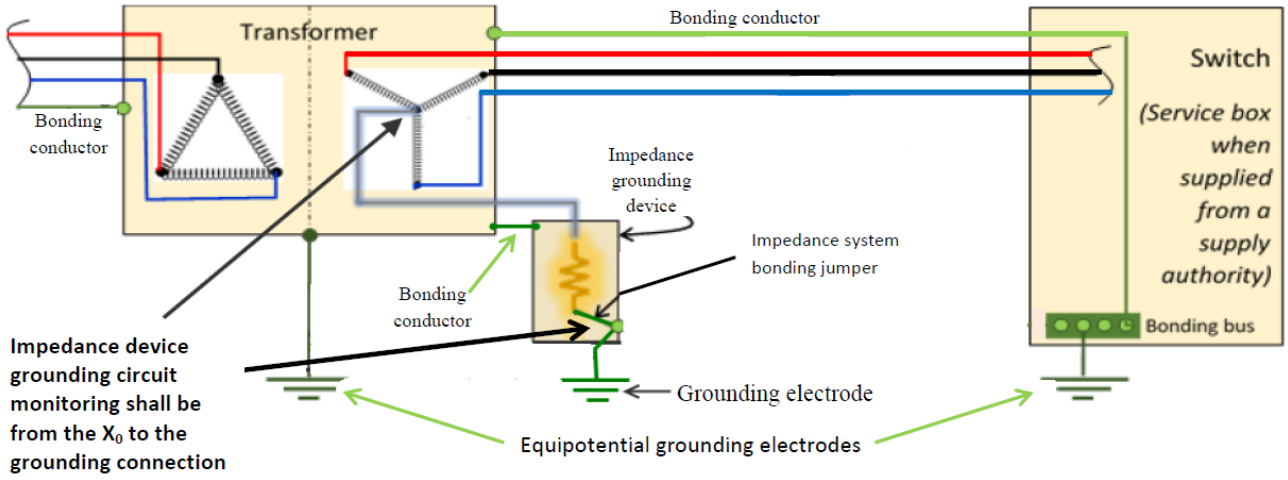
Impedance grounded systems are not solidly grounded systems. The conductor from the transformer/source to the impedance device must take the most direct route and is not required to enter the main service disconnect. This Rule provides a number of conditions that must be met with regard to this conductor. Minimum conductor size is now #12 AWG copper or #10 AWG aluminum conductors.

The path from the neutral point through the impedance grounding device to the system grounding electrode shall be electrically continuous, and monitored as per 10-302. See **Figure 8.**

10-400 - Ungrounded systems

Ground fault indication activated by a ground fault shall be visible to persons monitoring the status of the system and labeled 'CONTACT _____ IF LIGHT IS OUT OR SYSTEM IS IN ALARM'.

Regardless of other monitoring systems being implemented, each installation shall have fault indication lights and/or audible alarm. Installation conditions may dictate that both systems may be required (i.e. site conditions, noise levels, etc.).



The impedance grounded circuit shall be monitored from the X_0 to the connection to the grounding electrode.

Figure 8

10-604 - Bonding continuity for service equipment

The requirements for bonding are more restrictive at services than downstream from the main disconnect. Service equipment and enclosures may be called upon to carry heavy fault currents in the event of a line-to-ground fault. The service conductors in these enclosures have only short circuit protection provided by the overcurrent protective device on the line side of the utility transformer.

While there are various options available to assure the continuity of service equipment and enclosures, the use of a **bonding bushing** is the **only** acceptable method to ensure the bonding of metal conduits or the metal armour of cables that use locknuts as a method of attachment to an enclosure. When using a metallic service conduit on the line side of the main service, a bonding conductor and a bonding bushing is required.

10-606 - Bonding continuity at other than service equipment

The following Subrules have been put forward to the Part 1 for approval for the 2021 CEC and are being adopted now by the Electrical Inspections department.

a) The bonding conductor shall be permitted to be spliced or tapped ensuring sound electrical continuity.
b) Where more than one bonding conductor enters a box, all such conductors shall be in good electrical contact with each other by;
   a. securing all bonding conductors under bonding screws; or
   b. connecting them together with a solderless connector and connecting one conductor only to the box by a bonding screw or a bonding device.
c) Where a bonding conductor is run in the same raceway with other conductors of the circuit to which it is connected, it shall be insulated, except that an uninsulated bonding conductor shall be

d) Where circuit conductors are installed in a raceway, a separate bonding conductor, when required, shall be installed in the same raceway as the circuit conductors.
e) Where a separate bonding conductor is run with single-conductor cables, it shall follow the same route as the cables.

10-614 - Size of system bonding jumper or bonding conductor (see Appendix B)

1) The size of a field-installed system bonding jumper shall not be less that that determined by the application of Table 16 based on the ampere rating or setting of the overcurrent device protecting the ungrounded conductors.
2) The size of the bonding conductor installed in accordance with Rule 10-604 **at service equipment** shall not be less than that determined by the application of Table 16 based on the allowable ampacity of the largest ungrounded conductor. See **Figure 2 & 9.**
3) The size of a field-installed bonding conductor installed **at other than service equipment** shall not be less than that determined by the application of Table 16 based on:

a) the overcurrent device protecting the ungrounded conductors; or
b) the allowable ampacity of the largest ungrounded conductor for installations where the size of the circuit conductors is increased to compensate for voltage drop. See **Figure 9.**

4) The size of a field-installed bonding conductor installed with each group of parallel conductors run in separate raceways or cables, shall be in accordance with Subrule (3) divided by the number of groups of parallel conductors. See **Figure 9.**
5) Notwithstanding Subrules (2), (3) and (4), the bonding conductor shall not be required to be larger than the current-carrying conductors.
6) A metal raceway that is permitted to be used as a bonding conductor shall be considered to meet the requirements of this rule.
7) A bonding means that is integral to a cable assembly shall be considered to meet the requirements of this rule.

10-700 - Equipotential bonding of non-electrical equipment (see Appendix B)

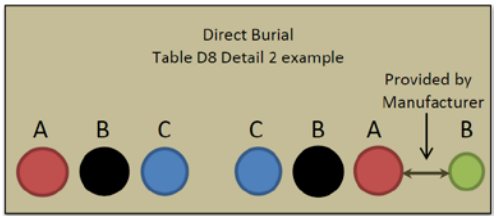
The metal parts of structures that livestock access shall be bonded as per 10-614(3) and shall include a connection to a grounding electrode at each location to provide an equipotential plane. This shall include buildings housing livestock, metal watering bowls and structures supplied with electricity within the areas accessible to livestock.

10-700(c) - Replacement of furnaces

When a furnace or similar piece of equipment is being replaced, the electrical contractor is responsible for bonding the gas line as required by the CEC. The branch circuit cable, providing it has an internal bond conductor as per Rule 10-610 and the low voltage thermostat cable, does not require replacement. See 26-806(1)(5)(6)(7).

Caution: Some new furnaces require 20 amp circuits.

Bonding conductor required in each raceway for parallel conductor installations.



Direct burial parallel conductor installations may require multiple bonds or a single bond sized to Table 16 and installed **as per manufacturer's instructions**

Figure 9

Notes: