Electrical Safety Authority

Residential HVAC and Hot Water Tank Installations

ESA-SPEC-007 R9

SPECIFICATION

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ESA SPEC-007 R9

The Electrical Safety Authority
July 8, 2022

ESA-SPEC-007-00 RESIDENTIAL HVAC AND HOT WATER TANK INSTALLATIONS

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The guideline herein do not have the force of law. In the event of a conflict between this guideline and any applicable legislation or regulation which may apply, including but not limited to the OESC, the relevant law prevails. The OESC is the law in Ontario and defines the legal requirements for safe electrical installations, products and equipment in Ontario. Omission herein of any requirements presently in the OESC does not in any way affect the OESC, nor should these omitted requirements be considered unimportant.

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ESA-SPEC-007-00 RESIDENTIAL HVAC AND HOT WATER TANK INSTALLATIONS

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(1) Wiring methods

(a) Liquid-tight flexible conduit

Liquid tight flexible conduit is permitted for wiring of a central air-conditioning unit from inside a building to the disconnecting means, and from the disconnecting means to the outdoor unit as a general purpose raceway when supported by straps, Type 2S or 21S cable ties, or other devices, similar to non-metallic sheathed cable requirements:

a) within 300 mm of every outlet box, junction box, cabinet, or fitting; and
b) with spacing between supports of not more than 1.5 m.

(b) Armoured cables

When armoured cable is field cut, the aluminum or steel edge is left sharp by the saw or cutter. A bushing, such as anti-short, is required to protect the conductors from damage. An anti-short bushing is also required to be installed in existing armoured cable if a furnace is replaced where a bushing was not present.

When armoured cable is not subject to mechanical damage by operation of the gas shut-off valve or other routine work, the electrical drop to the furnace that is usually in BX (armoured cable) may be secured to a black iron or copper gas line, provided the fastener for supporting the cable to the gas pipe is suitable for the purpose such as Type 2S or 21S cable ties approved for the application. Use of electrical tape is not acceptable as the adhesive on the tape will deteriorate with time and temperature, compromising the support. (See Photo 1).

Photo 1 – Use of electrical tape not acceptable for securing armoured cable to gas pipe or other support

If gas or other piping used for support is copper, then precautions need to be taken (Ontario Electrical Safety Code (OESC) Rule 2-116 2)) to ensure that galvanic corrosion between dissimilar metals is addressed (e.g. black tape armoured (BX) cable where it could contact copper pipe).

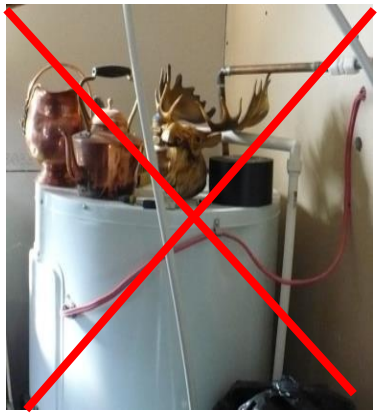
As per direction in OESC Bulletin 26-24-*, when armoured cable or BX is run in proximity to heating ducts or hot water pipes, an air space or a thermal barrier is an acceptable method of limiting the transfer of heat. Similar to non-metallic sheathed cable requirements, an air space should be at least

a) 25 mm between the conductor and heating ducts and piping;
b) 50 mm between the conductor and masonry or concrete chimneys; or
c) 150 mm between the conductor and chimney and flue cleanouts.

(c) Mechanical protection for non-metallic sheathed cable (NMSC)

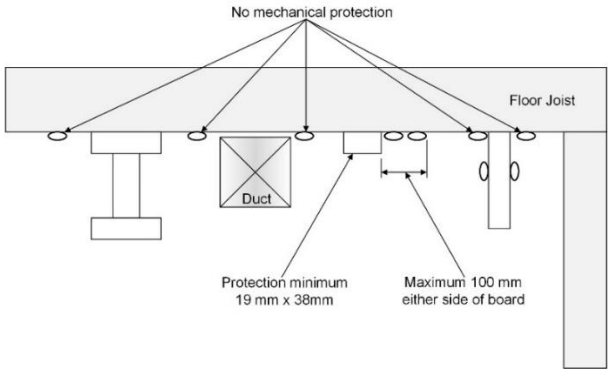
For a residential furnace or water heater drops, NMSC can be installed 1.5 m above floor level without mechanical protection. However, exposed NMSC within 1.5 m of the floor requires mechanical protection such as running the NMSC in flexible conduit or a raceway or replacement of the NMSC with armoured cable (BX). This includes cable drops to residential furnaces or hot water tanks where the cable is not protected by location (see Photo 2).

Photo 2 - NMSC not protected by location



Where NMSC is installed on the lower faces of basement joists, cables installed immediately adjacent to ducting or beams are considered as being suitably protected. Where cables are not in close proximity to ducts or beams, mechanical protection is required. This may be achieved by the use of a 19 mm x 38 mm guard strip. An additional guard strip will be required on opposite side of the NMSC if a distance of 100 mm cannot be achieved. Note: Objective is to not exceed the 100 mm distance from a guard strip. Some representative situations are shown in the Diagram 1.

Diagram 1 – Mechanical protection of NMSC installed on the lower faces of basement joists



(d) Where NMSC enters/ exits a raceway

When a raceway is used as mechanical protection for NMSC, the OESC requires bushings and/or box connectors to be used where the cable enters/exits a raceway or a cabinet for final connection to appliances such as furnaces, water heaters and central air conditioners.
As an alternative, sharp edges shall be removed from the ends of the raceway, the cable shall enter/exit in a line with the raceway and shall be supported within 300 mm of that point.

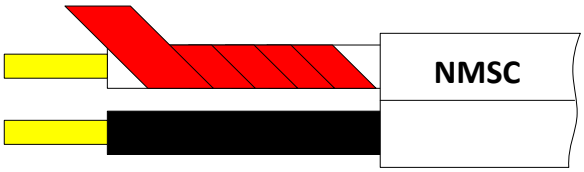
Acceptable equivalent protection to bushings is when sharp edges are removed from the ends of the raceway so that a raceway provides a smoothly rounded or flared entry for conductors and the cable enters/exits in a line with the raceway and is supported within 300 mm of end of raceway.

(e) Changing colour of multi-conductor cable

When installing NMSC or Armoured cable to feed:

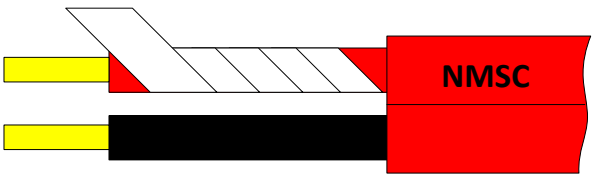
a) 240 V equipment, it is permitted to use a cable with a white and black conductor (OESC Rule 4-030), provided that any exposed portion of the white conductor is permanently changed at each accessible point in the circuit by coloured paint, sleeving, tape, or equivalent means (see Diagram 2).

Diagram 2



b) 120 V equipment as per Rule 4-024 4), it is permitted to use a cable with red and black conductor (Bulletin 4-5-*), provided that any exposed portion of the coloured conductor is permanently changed at each accessible point in the circuit by white paint, sleeving, tape, or equivalent means (see Diagram 3). The suitable means of marking the identified conductors shall not render illegible the manufactuer's numbering of the conductor.

Diagram 3



Note: When tape is used for marking of conductors it shall be applied as per CSA C22.2 No. 197 PVC insulating tape states: “The tape is intended to be applied in layers, each layer being half-lapped...”

Note: Where tape is used outdoors for identification of conductors at a supply connection point or similar location, “Weather Resistant” tape shall be used.

(f) Extra low voltage wiring

Extra low voltage (Class 2) wiring that operates a humidifier can be run inside a return air duct (drop at furnace) if a cable approved for the application such as type LVT is used.
When joining extra low voltage (Class 2) wiring for the furnace control, all joints need not be made in a box, if the joints are made with approved wire connectors and are accessible after completion of the installation.

(2) Ductless split systems, split A/C systems

(a) Wiring methods for ductless split systems

Cables and wiring methods permitted by Section 12 for interconnection of units in ductless mini-split air conditioners, shall be used if suitable for termination.

In addition, ESA will permit TC-ER cable (certified to CSA standard C22.22 No.230) to be used for interconnection of units in ductless mini-split air conditioners installations provided that it is installed:

- as per Rules 12-508, 12-512, 12-518 and 12-520;
- continuously supported; and
- not pulled through joists (structural members).

TC-ER cables comply with the crush and impact requirements of armoured (or metal clad) cables. Based on Rule 12-602 1), similar to armoured cables, TC-ER cables will be permitted to be installed on a building while being continuously supported.

Flexible cord (such as SJOOW (see Photo 3) is not allowed by the OESC Rule 12-402 3) to be used as a substitute for the fixed wiring of structures and shall not be

(i) permanently secured to any structural member;
(ii) run through holes in walls, ceilings, or floors; or
(iii) run through doorways, windows, or similar openings;

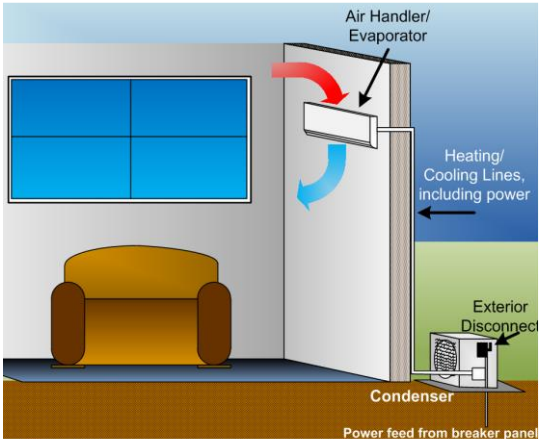
Photo 3 - SJOOW flexible cord used for interconnection wiring of a split system

As of June 2021, ESA no longer accepts cables certified to UL standard UL1277 such as Type TC cable marked as "TC-ER-JP", and Type PLTC for interconnection of units in ductless mini-split air conditioners.

(b) Refrigeration and air conditioning equipment split unit disconnect requirements

A disconnecting means is not required for an interior refrigeration or air conditioning equipment fan coil/evaporator unit, such as the indoor unit of a split A/C system (see Diagram 4), walk in coolers, etc.

Diagram 4 - Split A/C system



(3) HRVs, gas water heaters, furnaces and air conditioners

HRVs (heat recovery ventilators), special air cleaners and other equipment associated with the heating system, which are physically or not physically attached to the furnace, are permitted to be supplied by the furnace circuit.

- The OESC permits auxiliary equipment that is part of the furnace (such as a pump, valve, humidifier or electrostatic air cleaner, directly associated and operating in combination with the heating equipment) to be connected to the same branch circuit supplying the furnace

- Auxiliary equipment such as a humidifier, an air cleaner or a condensate pump are permitted to be connected to a receptacle (connected to the furnace branch circuit), provided the receptacle is mounted on the furnace and is AFCI protected. Refer to Bulletin 26-29-* for more information about AFCI protection.

A gas water heater that supplies both domestic hot water and heating equipment shall be supplied by a branch circuit that does not supply any other outlets or by the same branch circuit that supplies the heating unit and associated equipment.

A gas water heater is not required to have a separate branch circuit for a power vent and ignition circuit and shall not be connected to the furnace circuit. The receptacle for a gas water heater is permitted to be supplied by the required dedicated circuit for utility room receptacles or by any convenient general-purpose receptacle/lighting circuit, if the water heater is not located in the utility room

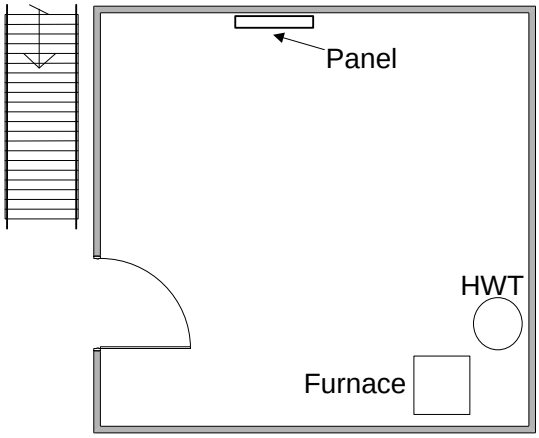
(a) Disconnecting means for furnaces

The following requirements apply to switches for furnaces using solid, liquid or gaseous fuel.

- A suitable disconnecting means for the furnace branch circuit (OESC Rule 26-806 5)).
- The circuit disconnect switch shall be permitted to be a branch circuit breaker in the panelboard, provided that the panelboard is located between the furnace and point of entry to the area (room) where the furnace is located (OESC 26-806 6)) (or may be at the point of entry to the room). The intent of Subrules 6) & 7) is that the panelboard is not located where it can be reached only by passing the furnace.
- The disconnecting means cannot be mounted on the furnace or in a location that can only be reached by passing close to the furnace (OESC Rule 26-806 7)).
- The following specific examples illustrate the requirements of the rule.

In Diagram 5, the panelboard breaker satisfies the rule. The panelboard is not in a location that can only be reached by passing close to the furnace. A separate switch on the path from the stairs to the furnace or on a post near the furnace, in anticipation of a future partition, is also acceptable. The possibility of a future wall around the furnace is not a factor until the wall is built.

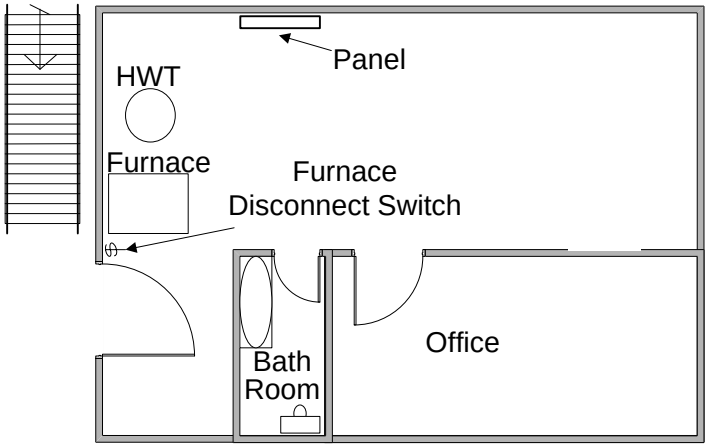
Diagram 5 – Breaker in a panelboard, acceptable disconnecting means for a furnace



When the panelboard is in an unsuitable location, as shown in Diagrams 6 (a) and (b), a separate disconnecting switch is required (OESC Rule 26-806 7)).

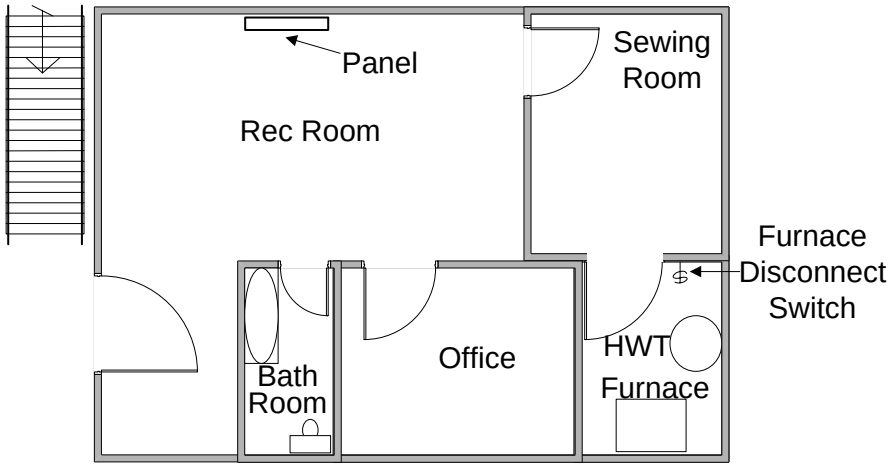
In Diagram 6 (a), a separate disconnecting switch is required just beside the entrance to the area where the furnace is located. The panelboard is in an unsuitable location because it is not located between the furnace and the point of entry to the area.

Diagram 6 (a)



In Diagram 6 (b) a separate disconnecting switch is required just beside the entrance to the room where the furnace is located. The panelboard is in an unsuitable location because it is located in a separate room

Diagram 6 (b)



(b) Air conditioners

When replacing an air conditioner, a disconnecting means is required (OESC Rule 28-604 5)) within sight and within 3m of the equipment if the air conditioner was installed previously without one.

It was common to see air conditioners installed without disconnecting means prior to 1994 when this requirement was added to the OESC. A replacement air conditioner has to meet the requirements of the current OESC.

- The air conditioner's disconnecting means shall be installed in a readily accessible location in accordance with OESC Rule 28-604 6), therefore it is not permitted to be mounted above or behind the air conditioning unit (see Photo 4). A working space of 1 metre square with secure footing in front of electrical equipment is also required (OESC Rule 2-308 1)). It would not be possible to service/operate the disconnect switch without leaning on the air conditioner without potential worker safety issues.

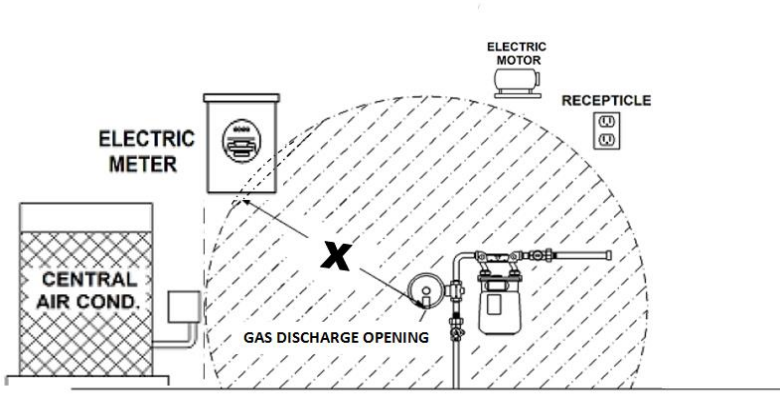
Disconnects installed outdoors for HVAC equipment can fail prematurely due to corrosion and the accumulation of moisture and dirt at the terminals which can lead to tracking across the phases. Condensation can be produced in a conduit that leaves a warm area and enters a cooler area, if the flow of warm air into the cooler area is not sealed off. To overcome the deteriorating effects of condensation on electrical equipment, a condensation is required to be mitigated by effectively sealing and draining the conduits connected to the control equipment. HVAC and refrigeration disconnects located outdoors must be suitable for the environment, Rule 28-602 5). If a conduit is used as a wiring method to a disconnect located in the enclosure, it must be drained and sealed in accordance with Rule 22-302

Photo 4 – 1 metre of working space required

Distances between an air conditioner or disconnect to a gas relief vent are based on minimum clearance requirements of CSA B149.1 between electrical equipment and gas relief sources (see Diagram 7). For more information see Bulletin 2-10-*

Diagram 7 – Minimum clearance required between electrical equipment and gas discharge opening

Fuel	Clearance (x)
Natural Gas with OPCO	0.3m
Natural Gas	1m
Propane	3m

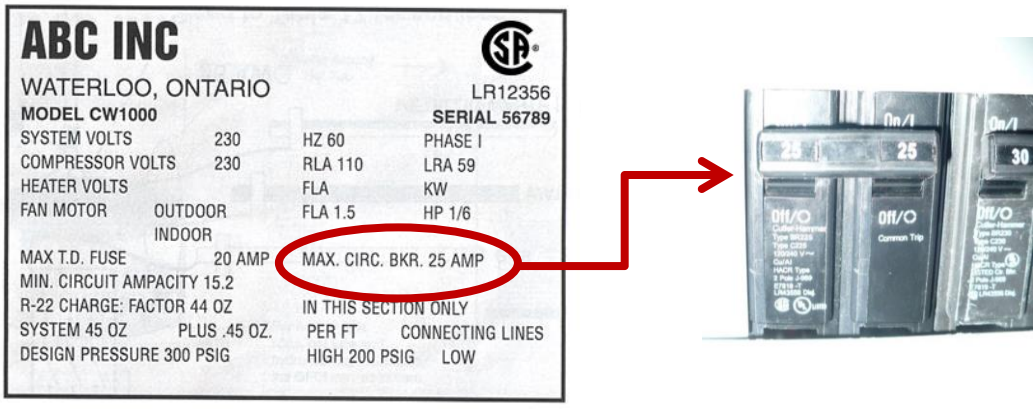


It is not permitted to exceed the maximum breaker size on an air conditioner nameplate (see Photo 5). The nameplate value is based on a calculation designed to protect the air conditioner, exceeding this value may cause a safety issue. Overcurrent protection is required to be sized as per the manufacturer's nameplate specifications (OESC Rule

02-034). If the breaker specified is not available, only a lower value is permitted to be installed.
When specified by the nameplate (see Photo 5), conductor ampacity is permitted to be smaller than the breaker size.

The maximum breaker size and minimum conductor size specified on a manufacturer nameplate are calculated by the manufacturer using relevant product standards (similar to a Section 28 motor calculation). For example, the nameplate in Photo 5, the minimum ampacity of the conductor is 15.2 A, No. 14 AWG conductor (20A - Table 2 @ 75°C) is permitted to be protected by a 25 A breaker.

Photo 5: Name Plate Example



(4) Equipotential bonding of non-electrical equipment

It is the intent of this section of the specification to clarify how to comply with the OESC requirements when a building with electric power contains metal gas piping.

Complying with the OESC may not necessarily meet all the requirements of The Technical Standards & Safety Authority (TSSA) - Gaseous Fuels Regulation (O. Reg. 212/01). Persons performing gas installations are reminded to consult with all other authorities having jurisdictions, including TSSA, to ensure all other codes and regulation requirements are met.

(a) Intent of equipotential bonding for metal gas piping systems

Rule 10-700 c) requires that metal gas piping of a building supplied with electric power to be made equipotential (the state in which conductive parts are at a substantially

equal electric potential) to non-current carrying conductive parts of electrical equipment. This bonding requirement applies to both natural gas and propane gas installations.

Where electrical wiring is present in the areas in which gas piping is installed, there is a possibility that the gas piping system, or appliance may become energized. Gas appliances, such as fireplaces and furnaces, may have electrical wiring installed right in the unit and in close proximity to the gas piping.

The intent of equipotential bonding of metal gas piping systems (Rule 10-700 c)) is to minimize hazards such as:

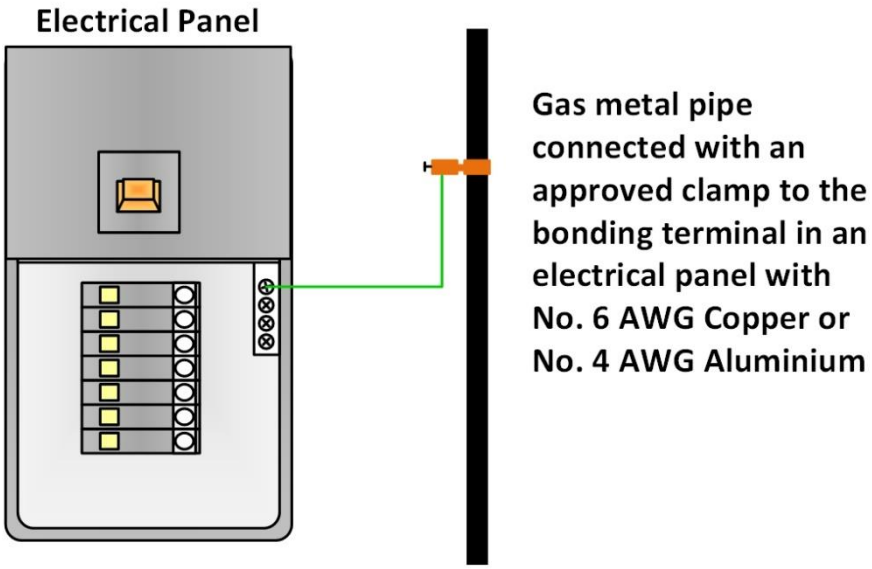
- incidental contacts between metal gas piping and energized electrical circuits,
- accumulation of static charges, and
- stray currents and potential differences between various sections of piping and electrical equipment.

(b) Means of equipotential bonding

Rule 10-708 1) requires an equipotential bonding conductor between the gas piping system and electrical equipment to be a minimum of No. 6 AWG copper or a No. 4 AWG aluminum conductor, with approved clamps suitable for the conductor size and type when run as open wiring (Diagram 8).

When run as concealed wiring and mechanically protected, Rule 10-708 2) permits the use of No. 10 AWG copper or No. 8 AWG aluminum.

Diagram 8 – Approved pipe clamp with a bonding conductor connected to a bonding bar in an electrical panel



Notes:

1. Rule 10-706 requires bonding connections to be mechanically secured.
2. Metal gas piping systems shall also be considered equipotential with electrical equipment when threaded into a gas-fired appliance with an electrical supply that contains a bonding conductor (Diagram 9)
3. Care should be taken not to have aluminum bonding conductors in contact with copper piping.

Diagram 9 – Gas piping equipotential with electrical equipment via electrical supply conductors

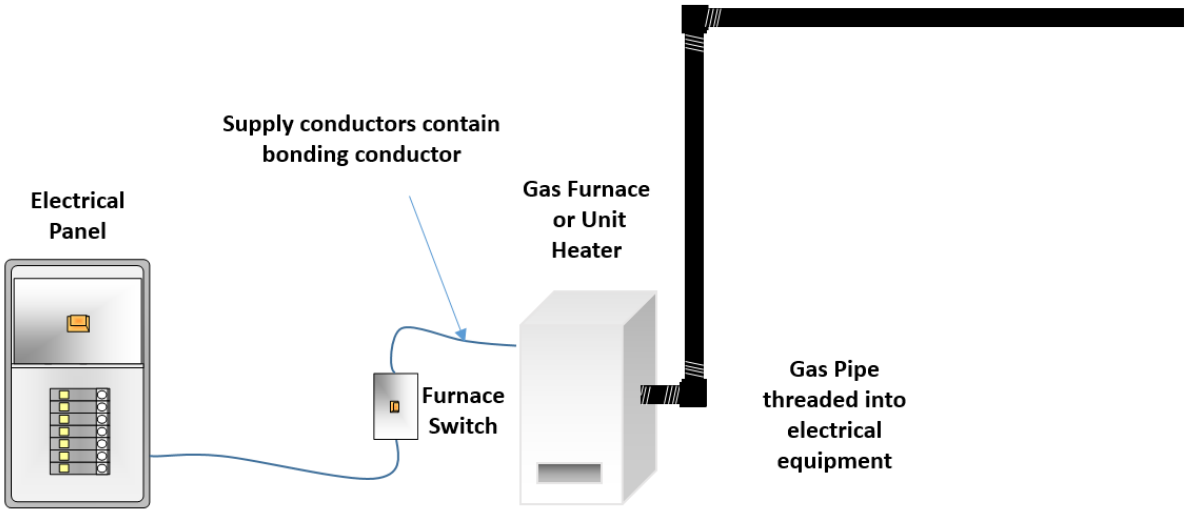
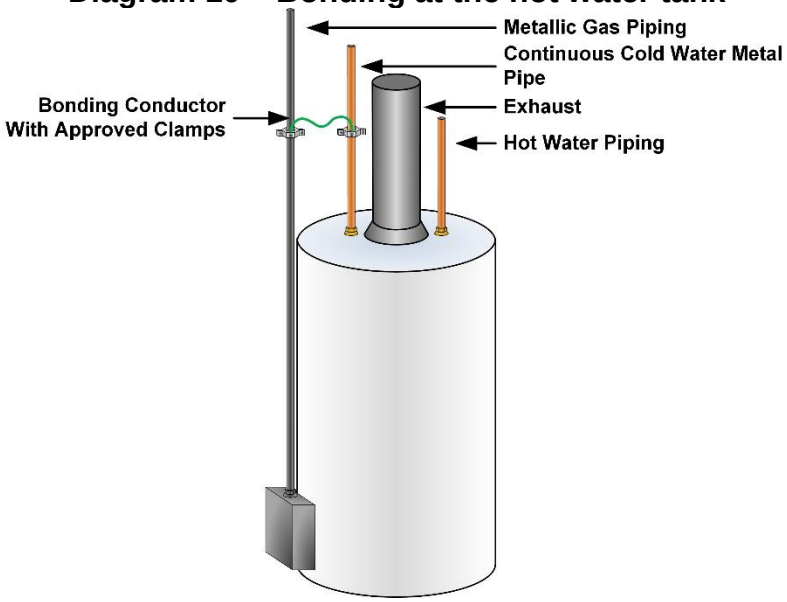


Diagram 10 – Bonding at the hot water tank



(c) Corrugated Stainless Steel Tubing (CSST) installations

ESA has received inquiries from the Gas industry about jurisdiction regarding CSST installation and inspection. The below information is intended to clarify responsibilities regarding CSST installation.

CSST is a product used by the gas industry and falls under the requirements of B149.1 “Natural Gas and Propane Installation Code”. Therefore, ESA is not the authority having jurisdiction looking after its installation or inspection.

CSST has different characteristics than metal gas piping. With CSST, there is increased risk of damage to the tubing from lightning strikes or improper grounding clamping methods, potentially causing a gas leak leading to a fire or explosion.

The installation of CSST is the responsibility of a person authorized to do such work in accordance with Ontario Regulation 215/01 (Fuel Industry Certificates) made under the Technical Standards and Safety Act, 2000

CSST is required to be grounded (direct-bonded) for lightning protection in accordance with TSSA requirements and manufacturer installation instructions. This requirement will also achieve equipotential bonding.

The installation of CSST including the bonding, lightning protection, etc. is:

- executed by a person competent and qualified to perform such work, as required by TSSA; and
- required to meet the manufacturer’s installation instruction as per Ontario Regulation 212/01 (Gaseous Fuels)

Note:

Rule 10-700 c) of the OESC does not require metal gas piping sections that are interconnected by CSST, to be bonded together with a bonding jumper. Intended safety is achieved by TSSA/manufacturer installation instruction requirements.

(d) Flexible HVAC ducts

If a flexible piece of duct is installed between the furnace and duct system, the OESC does not require bonding of metal duct systems in residential installations.

The gas system in a building is required to be bonded as per OESC Rule 10-700 with the non-current carrying conductive parts of the electrical equipment (see Diagram 11),

not to a separate ground electrode. Therefore, installation of a new ground plate or two new ground rods do not meet requirements of this Rule (see Diagrams 12 and 13).

Diagram 11 – Acceptable example of bonding

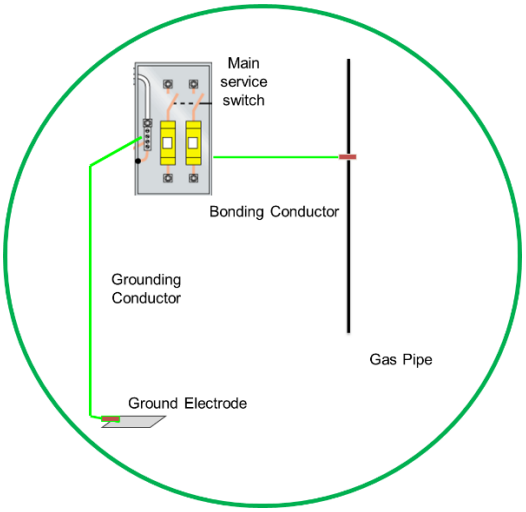
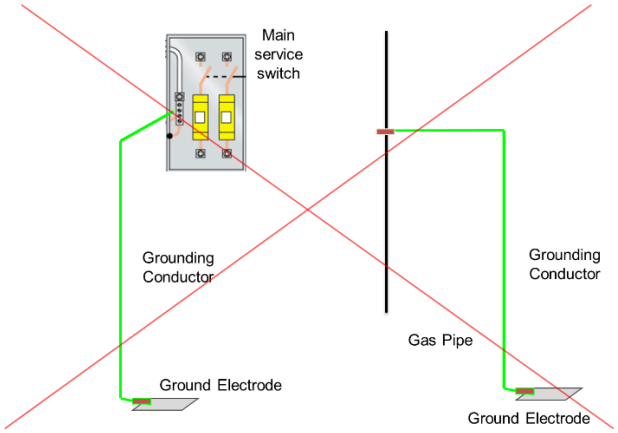


Diagram 12 – LP line connected to separate grounding electrode is not permitted

Diagram 13 – Separate ground electrode not permitted



The intent of this rule is to make all gas piping equipotential (at the same voltage) as the metallic parts of the electrical equipment within the building. A stand-alone electrode not connected to the building's electrical system does not accomplish this task and may put the gas piping at a different voltage than the building's electrical system. To prevent this difference in potential (Voltage), when multiple electrodes are installed at a building, they are required to be interconnected with a No. 6 AWG copper conductor or in some cases a No. 4 Aluminum conductor (OESC Rule 10-104).

(5) References

In addition to this document, several other Bulletins provide information about HVAC wiring installation requirements:

- Bulletin 2-10-* Electrical equipment near combustible gas equipment;
- Bulletin 4-5-* Identification of colouring of insulated conductors and cables
- Bulletin 10-14-* Bonding of non-electrical equipment;
- Bulletin 12-19-* Non-metallic sheathed cable wiring methods; and
- Bulletin 26-15-* Disconnect switch location for furnaces, ground source heat pumps, and central units.
- Bulletin 26-24-* Heating, ventilating, air conditioning (HVAC) & refrigeration installations