

Bulletin 12-19-17
Non-metallic-sheathed cable (NMSC) wiring methods
Rules 2-200, 4-004, 12-550, 12-564, 12-566, 12-568, 12-3012 and 12-3022 3)

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Scope

- 1) Bundling of non-metallic-sheathed cables (NMSC)
- 2) Protection of NMSC in concealed locations
- 3) Wiring methods for NMSC in a wall construction with rigid foam insulation
- 4) NMSC in buildings of non-combustible construction
- 5) Number of NMSCs per outlet box knockout
- 6) Mechanical protection and support of NMSC
 - a) In attic or roof spaces
 - b) On lower face of exposed ceiling joists
 - c) Within the island/peninsular cabinet
 - d) NMSC in residential return air plenum
 - e) Where NMSC is dropped from a ceiling or wall to appliances
 - f) Staples and ties use with NMSC
- 7) Installation of NMSC near heating ducts
- 8) Installation of NMSC between exterior brick and sheathing
- 9) Installation of NMSC in a conduit
- 10) Installation of NMSC in an underground conduit
- 11) Termination and splices of NMSC

1) Bundling of non-metallic-sheathed cables (NMSC)

Bundling non-metallic-sheathed cables together increases the temperature of the cables due to mutual heating and decreases the efficiency of heat dissipation. Rule 4-004 13) provides deration requirements where cables are run in contact for more than 600 mm by applying values that are indicated in Table 5C, refer to Bulletin 4-7-* for more information.

2) Protection of NMSC in concealed locations

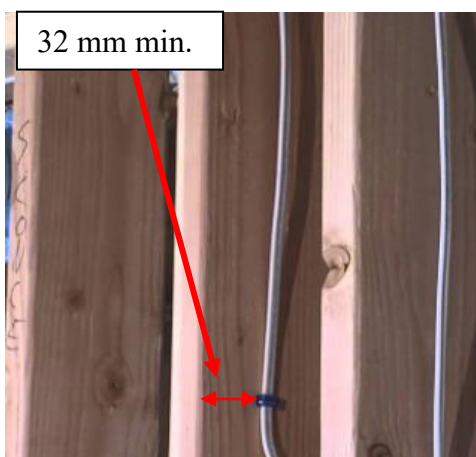
Rule 12-566 requires NMSC installed in concealed locations, to be effectively protected from mechanical damage, both during and after installation. When installing NMSC through studs, joists or similar members within 32 mm of the edge, Rule 12-566 1) permits protection plates or cylindrical bushings, specifically approved for the purpose as meeting the requirement for protecting cables. The use of sectional box sides is not acceptable to protect cables that are within 32 mm of the stud face since they are not approved for the purpose.

Question 1

Where cables are fanned out along the surface of a structural member and are within 32 mm of the edge, does the OESC require mechanical protection?

Answer 1

Yes, Rule 12-566 2) requires NMSC that runs along the surface of studs, joists or similar members to be kept a minimum distance of 32 mm from the edge that can be covered by drywall or similar material (See Photo B1). The intent of the rule is to provide protection of the cable from a screw missing the stud or joist. If the distance of 32 mm cannot be achieved, then protection in the form of an approved corrosion resistant ferrous metal not less than 1.3 mm thick will be required to cover the width of the cable or group of cables. (See Photo B2).

Photo B1 – NMSC installed along a stud**Photo B2 – Example of protection of NMSC installed along a stud**

Rule 12-566 3) permits the use of NMSC with metal stud construction. Where NMSC is used in metal stud construction, approved inserts (grommets) adequately secured in place is required to protect the cable where it passes through the metal stud in accordance with Rule 12-566 3) b). Round inserts are approved for a given size opening in a steel stud. If inserts are loose fitting or can be easily removed, they are not adequate for that installation and shall be replaced or installed in properly sized holes. Improperly installed inserts can lead to cable insulation failures. Installation of NMSC in steel stud construction will not be accepted where the standards of workmanship or the type of inserts used results in the inserts not staying in place.

Question 2

Is it acceptable to fish NMSC into a metal stud wall?

Answer 2

No, Rule 12-670 does not permit cables to be fished where metal joists, metal top or bottom plates, or metal studs are used.

3) Wiring methods for NMSC in a wall construction with rigid foam insulation

Several types of wall systems that incorporate rigid foam insulation as a part of the wall construction are available where the insulation constitutes the concrete form. Where the Insulated Concrete Form (ICF) method of construction is used, the wall finish (e.g. - drywall) may be fastened to supports embedded in the rigid insulation. Questions have been raised regarding the wiring methods of NMSC, i.e., depth of cable channels into the insulation behind the interior wall finish, and acceptable outlet box installation methods.

NMSC is acceptable in this type of installation. There is presently no requirement for NMSC to be spaced away from the finished wall surface, other than at drywall attachment supports, where there must be compliance with Rule 12-566 (conductors spaced 32 mm back from the edges of the supports or mechanical protection shall be provided). Where cables are installed in channels cut into the foam, the bundling requirements in any channel are outlined in Topic (1) of this Bulletin.

The use of spray foam polyurethane insulation in walls that have NMSC already installed in a manner that is in compliance with the OESC is also acceptable.

In wall systems where ICF is used as a permanent form for poured concrete, boxes shall be fastened to the structural member that is integral to the form, or through the back of the box to the concrete behind the rigid insulation using two fasteners, as required by Rule 12-3010 1) (See Photo B3). Boxes with a flat rear surface, such as masonry type boxes or one piece utility boxes, suitably spaced to ensure the front edge is within 6 mm of the finished wall surface, are recommended where the space between structural members is used (i.e. attached to the concrete behind the box with two fasteners). Where ganged sectional boxes are used, additional support is required by Rule 12-3010 (i.e. additional support to concrete).

Photo B3 – Typical box installation in ICF form



4) NMSC in buildings of non combustible construction

The jacket on NMSC is typically rated FT1, which makes it ineligible for use in buildings required to be of non combustible construction in accordance with the Ontario Building Code (OBC) (as referenced by Rule 2-130 and Bulletin 2-8-*). However, the OBC does permit cables with combustible jackets, where they are installed in a totally enclosed metallic raceway or a totally enclosed non-metallic raceway, with flame test marking “FT4”, or in concealed spaces within a wall. Extension of the cable into bulkheads or concealed ceiling spaces is in violation of the OBC.

5) Number of NMSCs per outlet box knockout

The OESC does not permit more than one NMSC per pry out using the internal clamp. CSA Standard C22.2 No. 18 (Outlet Boxes, Conduit Boxes, and Fittings) tests for pullout and voltage withstand after exposure to an elevated temperature are done with one cable per clamp. Use of more than one cable per clamp is a misapplication.

The standard does recognize box connectors that are approved to accommodate more than one cable and such connectors can be used with more than one cable, up to the limit stated by the manufacturer.

6) Mechanical protection and support for NMSC

a) In attic or roof spaces

Rule 12-564 1) a) requires exposed NMSC to be protected from mechanical damage on the upper face of a ceiling joist or lower face of a rafters in attic or roof spaces with the use of a guard strip when the distance between the joists and rafters exceeds 1 m. The size of the guard strip will be dependant on the location. When installed on the upper face of a ceiling joist, Rule 12-564 4) requires the board to be at least 38 mm x 38 mm in size, where as Rule 12-564 2) requires the board to be sized at least 19 mm x 38 mm on the lower face of a roof rafter.

Question 3

What is the maximum distance a NMSC can be installed from the edge of a guard strip when installed on the upper face of a ceiling joist or on the lower face of rafters in an attic or roof space?

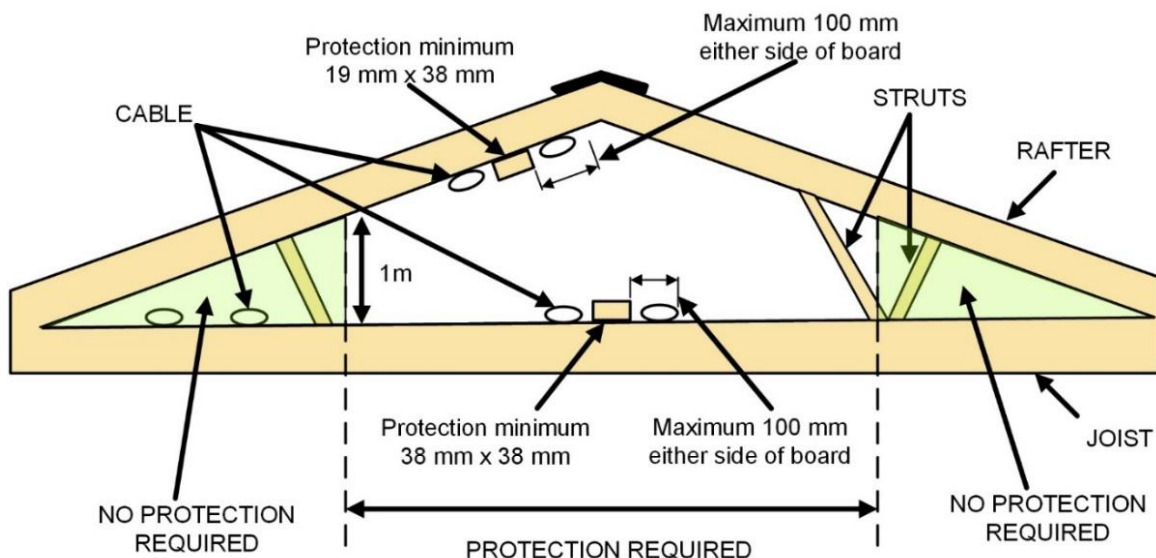
Answer 3

100 mm. An additional guard strip will be required on opposite side of the NMSC if distance cannot be achieved. Note: Objective is to not exceed the 100 mm distance from a guard strip. See Diagram B1.

Rationale 3

The intention of this rule is to prevent damage to the conductors while walking in the attic during and after construction, as well as storage of material in non-insulated areas.

Diagram B1 – Mechanical protection of NMSC installed in the attic and roof space



Question 4

Does Rule 12-560 require NMSC to be supported by straps or other devices, when run through attics across the upper faces of ceiling joists, where the vertical distance to the rafters is less than 1m, in compliance with Rule 12-564 1) a), as shown in Diagram B2?

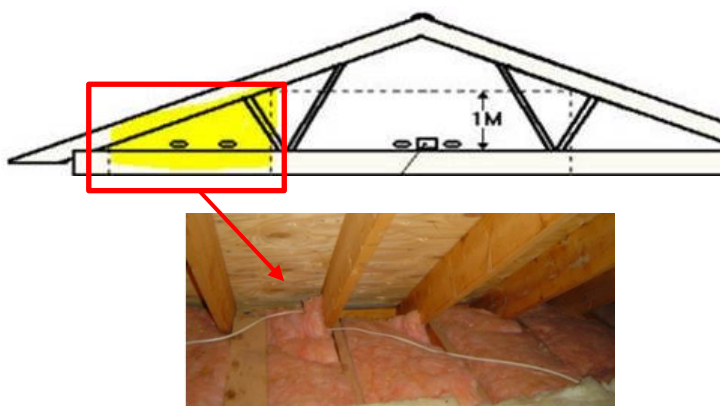
Answer 4

Yes, however, notwithstanding the requirements of Rule 12-560, the strapping shall be permitted to be omitted.

Rationale 4

The cable is not subjected to damage. Installers often do not fit in these small areas and there is also not enough room to swing a hammer. Improper installation of a strap on cable not in full view of the installer may actually subject it to damage.

Diagram B2 – Support for NMSC with less than 1 m vertical clearance in an attic



b) On the lower face of exposed ceiling joists

Rule 12-564 1) b) requires exposed NMSC to be protected from mechanical damage on the lower face of exposed ceilings. Questions have arisen concerning acceptable mechanical protection, where NMSC is installed on the lower faces of ceiling joists. Cables installed adjacent to ducting with an air space no closer than 25 mm as required in accordance with Rule 12-556 4), beams or by location 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 guard strips sized at least 19 mm x 38 mm in accordance with Rule 12-564 2). Some representative situations are shown in the Diagram B3.

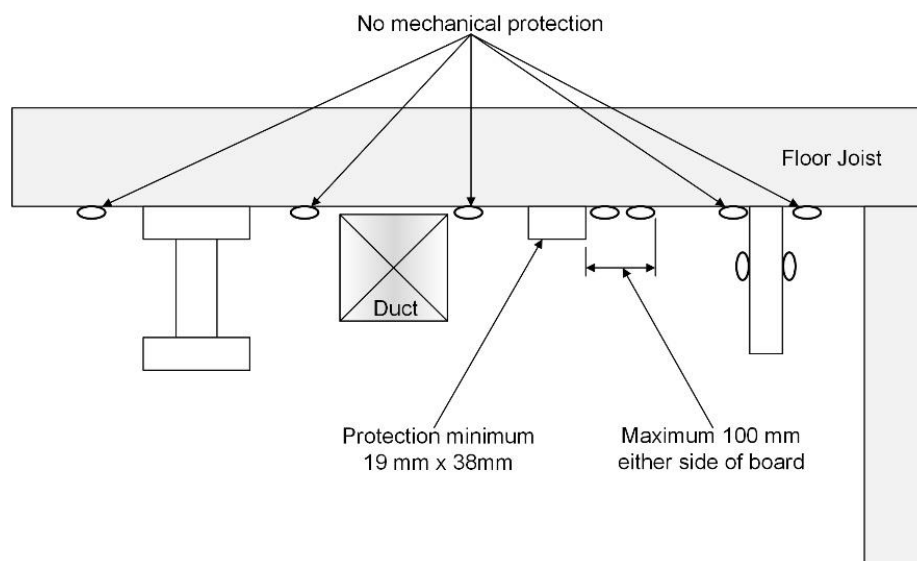
Question 5

What is the maximum distance a NMSC can be installed from the edge of a guard strip when installed on the lower face of a ceiling joist?

Answer 5

100 mm. An additional guard strip will be required on opposite side of the NMSC if distance cannot be achieved. Note: Objective is to not exceed the 100 mm distance from a guard strip. See Diagram B3.

Diagram B3 – Mechanical protection of non-metallic-sheathed cable installed on the lower faces of ceiling joists

**c) Within the island/peninsular cabinet****Question 6**

What are the OESC requirements for mechanical protection of NMSC installed within the island/peninsular cabinet?

Answer 6

Rule 12-568 requires NMSCs to be protected from mechanical damage where they pass through floors, are located less than 1.5 m above a floor or where they are exposed to potential damage. Therefore, where NMSC passes through a floor within the island/peninsular cabinet; or **where NMSCs are installed within the cabinets, they require mechanical protection, unless protected by location.**

Rationale 6

If NMSC is installed within the island/peninsular cabinet so that opening or closing the drawers can damage the cable; or if a cable is exposed to damage when people are storing items in the cabinet, mechanical protection is required by Rule 12-568 to protect the cable.

Means of mechanical protection may consist of flexible conduit, wood channel or other means which will provide adequate protection.

If a cable is protected by a built-in appliance, such as dishwasher, behind the plumbing pipes or below the countertop, not accessible to people storing items in the cabinet below, NMSC is considered to be protected by location.

d) NMSC in a residential return air plenum

Question 7

Is it permitted to fish NMSC lengthwise in a residential return air plenum, boxed with sheet metal?

Answer 7

No, Rule 12-570 does not permit cables to be fished where metal sheeting or cladding, metal joists, metal top or bottom plates, or metal studs are used.

Photo B4 shows an example of the mechanical hazards that may be encountered if a cable is fished through the cold air return in a dwelling unit.

Photo B4 – An example of the mechanical hazards that may be encountered if a cable is fished through the cold air return in a dwelling unit



Question 8

Is it acceptable to pass NMSC through the sides of a return air plenum, boxed with sheet metal?

Answer 8

Yes, Rule 12-566 3) permits the passing of a cable through the return air plenum if it is protected where it passes through a member by an insert approved for the purpose and adequately secured in place.

e) Where NMSC is dropped from a ceiling or wall to appliances

NMSC that is used in exposed wiring shall be adequately protected against mechanical damage, as required by Rule 12-568, where it is installed at a height of less than 1.5 m above the floor or anywhere else it is exposed to mechanical damage. Examples of this include a cable drop from a ceiling or a wall to appliances such as furnaces, water heaters, etc.

The preferred method of compliance is to install a junction box and convert to armoured cable for the drop. Other methods include the use of raceways, such as flexible metal conduit, EMT, rigid PVC, liquid tight flex, etc., as protective sleeving over the NMSC where it drops to the appliance. Note that Rule 12-1502 does not permit ENT to be used for this purpose when the height is less than 1.5 m above the floor.

NMSC can also be protected by location from mechanical damage. For example, NMSC installed between the appliance and gas pipe drop is considered to be mechanically protected by the pipe. The NMSC can be supported to the gas pipe, provided it does not interfere with any of the pipe fittings.

Where cable is used for the drop, it shall be supported by a “band-all” strap, fixture chain, duct cleat material, or similar means that is secured to the building structure and the appliance. The cable shall be secured neatly in place to the support with permanent fastening means such as straps or Type 2S or 21S cable ties, approved for the purpose or the equivalent, as per Rule 12-560 4). The use of tape is not acceptable as a fastening means.

Item 9 of this bulletin provides additional information on the OESC requirements when using a raceway as a sleeve for protection of NMSC.

f) Staples and ties for use with NMSC

Questions have been asked regarding the number of NMSCs that may be supported by a cable staple. Cable staples are approved to support one cable only, unless manufacturer documentation is provided to confirm certification for fastening of more than one cable. Supporting more than one cable with a staple that is not approved for fastening more than one cable is a violation of Rule 2-034, which requires equipment to be used only for the specific purpose for which it is approved.

Note

NMSC straps are available and certified for use for the support of two cables stacked under one staple. This is acceptable where documentation from the manufacturer supports this practice. Examples of acceptable supporting documentation would include information on packaging or electronic or written information from manufacturer.

Question 9

Is it permitted to support NMSC to the structure by means of a staple and approved nylon cable ties?

Answer 9

Yes, provided that cable ties such as Types 2S and 21S which are considered suitable for the support of cables and raceways, according to Rule 12-560.

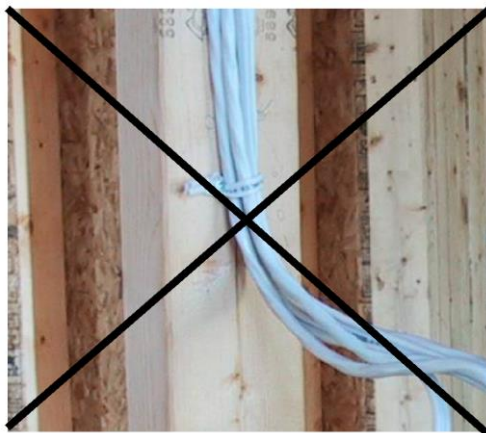
Question 10

Is it permitted to secure NMSC to the structure by means of discarded sheathing of NMSC?

Answer 10

No, the use of discarded NMSC as a fastener to bundle cables to studs is not accepted. Photo B5 shows a non-Code compliant installation.

Photo B5 – The use of discarded NMSC as a fastener to bundle cables to studs is not accepted



7) Installation of NMSC near heating ducts

The interference of metal heating ducts with an electrical installation is often a problem, particularly in domestic installations. Inspectors have found NMSCs in contact with metal heating ducts. The wiring may be damaged when heating ducts are installed in close proximity to the NMSCs.

In addition to the shock and fire hazard presented by this type of installation, the life expectancy of the wiring is reduced.

Where defects of this nature have been found, the contractor is required to correct the defects by re-routing the cable or inserting thermal insulation between the cable and the duct, in accordance with Rule 12-556 5).

Also note that the transfer of heat to NMSC shall be minimized by means of an air space of at least 25 mm between the conductor and heating supply ducts and piping, in accordance with Rule 12-556 4).

8) Installation of NMSC between exterior brick and sheathing

We have received inquiries about NMSC installed in the space between the brick and the insulating material installed on the exterior of the wood wall studs of a house. The main concern we have is possible mechanical damage to the cable through contact with the brick ties, during or after their installation (Rule 2-200). In order to minimize the possibility of damage to cables in these situations, the following restrictions apply:

The cable can be run in the space between the sheathing and the brick provided:

- a) The cable feeds only an exterior outlet (e.g. receptacle or light) mounted in or on the exterior brick wall.
- b) The cable length is kept to a minimum.
- c) The cable is securely supported in an acceptable manner to the sheathing and is adequately separated from brick ties and sharp edges of building materials.

Photo B6 shows a non-Code compliant installation.

Photo B6 – Installation of NMSC between exterior brick and sheathing; non-Code compliant installation



The intent of this direction is to accommodate very short cable runs to specific exterior outlets. The wiring method cannot be used for wiring between or to interior outlets.

9) Installation of NMSC in a conduit

Questions have been asked whether NMSC can run in a raceway that terminates in an enclosure. For example, where NMSC enters into short lengths of raceway for final connection to appliances such as furnaces, water heaters, central air conditioners; or

where NMSC is installed in rigid PVC conduit to residential panels, an example of Photo B7 below.

Photo B7 – Installation of in rigid PVC conduit to a panel



Notwithstanding Rules 12-918 and 12-3022, Rule 12-568 2) permits non-metallic conduit or tubing to be used as a sleeve for mechanical protection *for NMSC when cables are protected from abrasion entering the raceway and conduit fill is in accordance with Table 8. In addition:

- the NMSC is secured 300 mm of termination or prior to entering the conduit;
- the jacket extends into enclosure by 25 mm; and
- the conduit is sealed or installed in a manner that will prevent foreign objects from dropping into the enclosure (LB or similar fitting would meet the intent).

*Note: ENT is permitted to be used to protect NMSC when above 1.5 m above floor.

10) Installation of NMSC in an underground conduit

Questions have been asked if NMSC approved for dry or damp locations is permitted to be installed in an underground conduit.

Question 11

Is it acceptable to install an NMD90 conductor in a PVC underground conduit?

Answer 11

No, Rule 12-930 states raceways installed underground or in concrete slabs, in direct contact with the earth, shall comply with Section 22 Rules for Category 1 locations.

Rule 22-200 2) requires individual conductors and NMSC in Category 1 areas to be suitable for use in wet locations. Notwithstanding Rule 12-902 and Table 19, NMWU cable is permitted in a raceway.

NMD90 is suitable for use in dry or damp locations only.

11) Termination and splices of NMSC

Question 12

Is it permissible to drill, punch, or use a hole saw to create additional openings in the back of non-metallic or metallic outlet boxes, to accommodate entry of cables without a connector?

Answer 12

No, drilling, punching or using a hole saw to create additional openings in the back of non-metallic or a metallic outlet box is not acceptable for this application. As previously noted, CSA Standard C22.2 No 18 “Outlet Boxes, Conduit Boxes, and Fittings” requires tests for cable pullout, to avoid stress on conductor terminations. In addition, Rule 12-3022 1) a), b) and e) require a box connector for a cable entering an outlet box, which includes boxes mounted in exterior brick walls. The connector prevents damage of conductors from sharp edges. Photo B8 shows a non-Code compliant installation.

Photo B8 – A conductor that is not protected from sharp edges; non-Code compliant installation



Question 13

Can a NMSC tap and splice kit (see Photo B9) be used to splice or tap NMSC in concealed locations where they are not accessible?

Answer 13

No, these products may only be installed in accessible locations such as basements, attics, or other areas where access is available as per Rule 12-112 4). Joints or splices in wires and cables shall be accessible. As well, the connectors must be approved for the type, size and number of cables and conductors being used.

Photo B9 – Example of tap and splice kit for NMSC

