

Bulletin 12-19-11
Non-Metallic-Sheathed Cables (NMSC) wiring methods
Rules 2-034, 2-200, 4-004, 12-500 to 12-526, 12-3012 and 12-3022(3)

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Scope

- (1) Bundling of NMSC
- (2) Installation of NMSC in metal stud construction
- (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 as per Rule 12-514(a)
 - (b) On lower faces of basement joists as per Rule 12-514(b)
 - (c) In concealed spaces as per Rule 12-516(1)
 - (d) Within the island/peninsular cabinet
 - (e) NMSC in residential return air plenum
 - (f) Where NMSC is dropped from a ceiling or wall to appliances
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(1) Bundling of NMSC

Bundling non-metallic sheathed cables together increases the temperature of the cables due to mutual heating and decreases the efficiency of heat dissipation. **Refer to Bulletin 4-7-* for more information**

(2) Installation of NMSC in metal stud construction

Rule 12-516(2) permits the use of non-metallic-sheathed cable with metal stud construction. Where NMSC is used in metal stud construction the following are installation requirements:

- Approved inserts (grommets) to protect the cable where it passes through the metal stud. The inserts referred to in Rule 12-516(2)(b) must be approved for the purpose and adequately secured in place.
- 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.
- The 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.
- **The cable must have adequate mechanical protection.** Protection plates are required in all locations where NMSC is within 32 mm from the edge of steel studs in accordance with Rule 12-516(1).

Question 1

Is it acceptable to fish non-metallic-sheathed cable into a metal stud wall?

Answer 1

No, Rule 12-520 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 becoming popular. The interior wall finish (e.g. - drywall) may be fastened to supports imbedded 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 12-516 (conductor space 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 the rigid foam board is used as a permanent form for poured concrete, boxes shall be fastened through the back of the box to the concrete behind the foam using two fasteners approved for the purpose, or to a structural channel at one point and to the concrete at another point. Sectional boxes are permitted, however gluing is not an acceptable fastening method, and boxes must be securely fastened as per Rule 12-3012. Boxes with a flat rear surface such as type "mbd" boxes, or one piece utility boxes suitably spaced to ensure the front edge is within 6 mm of the finished wall surface, are recommended.

(4) NMSC in buildings of non combustible construction

The jacket on NMSC is normally rated FT1 which makes it ineligible for use in buildings required to be of non combustible construction by the Ontario Building Code (as referenced by Rule 2-126 and Bulletin 2-8-*). However, the Ontario Building Code 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 space in a wall. Extension of the cable into bulkheads or concealed ceiling spaces is in violation of the Ontario Building Code.

(5) Number of NMSCs per outlet box knockout

The OESC does not permit more than one non-metallic sheathed cable in one 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 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

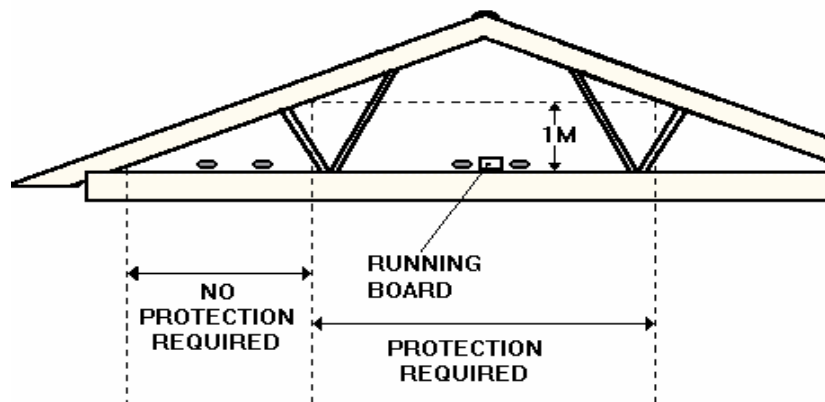
(a) In attic or roof spaces as per Rule 12-514(a)

Rule 12-514 states that NMSCs are not to be run on the upper faces of ceiling joists or the lower faces of rafters in attics or roof spaces, where the vertical distances between the joists and the rafters exceeds 1 m (3.28 feet). If the distance between the joist and the rafter exceeds 1 m, then runs across the rafters are acceptable provided a running board is used.

Rationale

The intention of this rule is to prevent damage to the conductors while walking or from storage of material in the attic. Some representative situations are shown in Diagram B1.

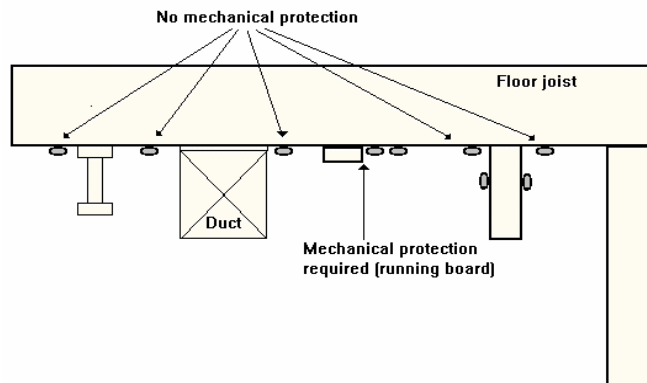
Diagram B1 – Mechanical protection of non-metallic-sheathed cable installed in the attic



(b) On lower faces of basement joists as per Rule 12-514(b)

Questions have arisen concerning acceptable mechanical protection 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 running boards. Some representative situations are shown in the Diagram B2.

Diagram B2 – Mechanical protection of non-metallic-sheathed cable installed on the lower faces of basement joists



(c) In concealed spaces as per Rule 12-516(1)

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Question 2

Where cables are fanned out on the surface of a structural member and are within 32 mm of the edge does the Ontario Electrical Safety Code require mechanical protection?

Answer 2

No, Rule 12-516(1) only requires mechanical protection where cables are run through structural members, not along them. Good trade practice would be to keep them back at least 32 mm from the edge when run along structural members; however the code does not require it.

We have been advised by several contractors of instances of cables that were fanned out one per staple being damaged by either a drywall screw or a siding nail that has gone astray.

(d) Within the island/peninsular cabinet

Question 3

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

Answer 3

Rule 12-518 requires NMS cables 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 NMS cables are installed within the cabinets, they require mechanical protection unless protected by location.**

Rationale 3

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 12-518 to protect the cable.

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

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

(e) NMSC in a residential return air plenum

Question 4

Is it permitted to fish non-metallic-sheathed cable lengthwise in a residential return air plenum boxed with sheet metal?

Answer 4

No, Rule 12-520 does not permit cables to be fished where metal joists, metal top or bottom plates, or metal studs are used.

The Photo B1 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.

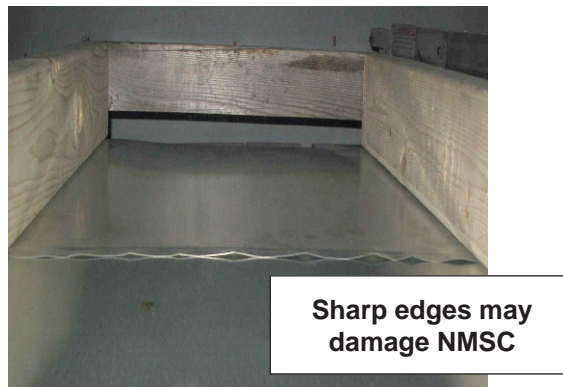
Question 5

Is it acceptable to pass non-metallic sheathed cable through the sides of a return air plenum boxed with sheet metal?

Answer 5

Yes, Rule 26-516-2 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.

Photo B1 – An example of the mechanical hazards that may be encountered if a cable is fished through the cold air return in a dwelling unit



(f) 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 12-518 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. This includes 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 Rules 12-1500 and 12-1502 do not permit ENT to be used for this purpose.

NMSC can also be protected by location from mechanical damage. For example, NMSC installed between the appliance and gas pipe drop is considered as 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 “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 nylon cable ties or the equivalent. The use of tape is not acceptable as a fastening means.

Where raceway is used for the drop, it shall be secured to both the building structure and the appliance. Bushings and/or box connectors shall be used where the cable enters/exits the raceway or a cabinet as required by Rules 12-906 and 12-3022(3). As an alternative, sharp edges shall be removed from the ends of the raceway and the cable shall enter/exit in a line with the raceway and shall be supported within 300 mm of that point in accordance with Rules 12-508 and 12-510.

(g) Where NMSC enters/exits raceway

Question 6

What does the Code require where NMSC enters into short lengths of raceway for final connection to appliances such as furnaces, water heaters, central air conditioners, etc?

Answer 6

Rules 12-906(1) and 12-3022(1)(a)(b)(e) require bushings and/or box connectors to be used where the cable enters/exits a raceway or a cabinet. As an alternative, sharp edges shall be removed from the ends of the raceway and the cable shall enter/exit in a line with the raceway and shall be supported within 300 mm of that point in accordance with Rules 12-510.

Rationale 6

There are several rules that provide direction: Rule 12-906(1) requires the installation of a bushing or equivalent means to protect conductors from abrasion where they issue from a raceway; Rule 12-3022(3) requires a box connector where NMSC enters into an enclosure; and Rule 12-510 requires NMSC be supported within 300 mm of terminations. 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.

(h) Where NMSC enters into outlet box

Question 7

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

Answer 7

No, drilling, punching or hole sawing additional openings in the back of non-metallic and metallic outlet boxes 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 12-3024(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 the damage of conductors from sharp edges. The Photo B2 shows a non-Code compliant installation.

Photo B2 – A conductor that is not protected from sharp edges; non-Code compliant installation



(i) Staples and ties 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 8

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

Answer 8

Yes, provided the approved cable ties are rated 23 kg (50 lbs) or greater and the bundled cables are not in contact for a distance greater than 600 mm (2 feet), this practice is acceptable. CSA Standard C 22.2 No. 18.5 recognizes the use of cable ties for securing cable and wire.

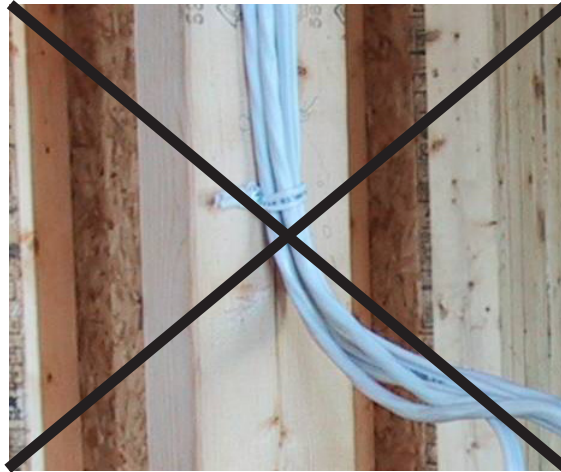
Question 9

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

Answer 9

No, the use of discarded NMSC as a fastener to bundle cables to studs will no longer be accepted. The Photo B3 shows a non-Code compliant installation.

Photo B3 – The use of discarded NMS cable 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 rerouting the cable or inserting thermal insulation between the cable and the duct in accordance with Rule 12-506.

(8) Installation of NMSC between exterior brick and sheathing

Also note that the transfer of heat to non-metallic sheathed cable 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 12-506.

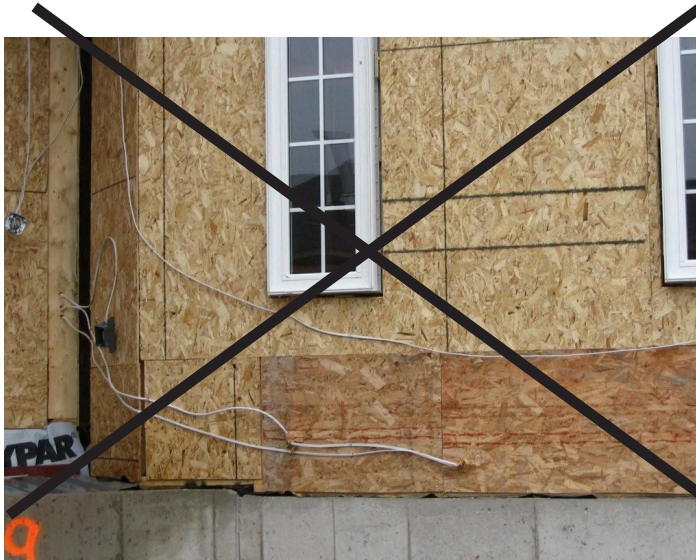
We have received inquiries about NMSC installed in the space between the brick and the insulating material installed on the exterior of the wood wall studs of a house. The main concern we have is possible mechanical damage to the cable through contact with the brick ties, during or after their installation (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.

The Photo B4 shows a non-Code compliant installation.

**Photo B4 – 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.