

*The National Armored Cable
Manufacturers Association
Presents*

**Installation Standard for
Types AC and MC Cables**

An ANSI Standard

- ◆ Original document jointly produced by NECA and NACMA as *“Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC)”* NECA/NACMA 120-2006



Session Outline

1. Scope
2. Glossary
3. Identification of Cables
4. Armored Cable (Type AC)
5. Metal-Clad Cables (Type MC)
6. General Installation Procedures

Session Outline

7. AC Cables—Specific Installation Procedures
8. MC Cables—Specific Installation Procedures
9. Type MC Cables in Hazardous (Classified) Locations

1. Scope

- ◆ This document covers the selection and installation of Type AC and Type MC cables.
- ◆ It also includes information on fittings.
- ◆ This document is intended to enhance electrical safety. Only qualified persons should install cables
- ◆ All information in this publication is intended to comply with the National Electrical Code (NFPA 70). Installers should always follow the NEC, applicable state and local codes, and manufacturers' instructions when installing electrical products and systems.

2. Glossary

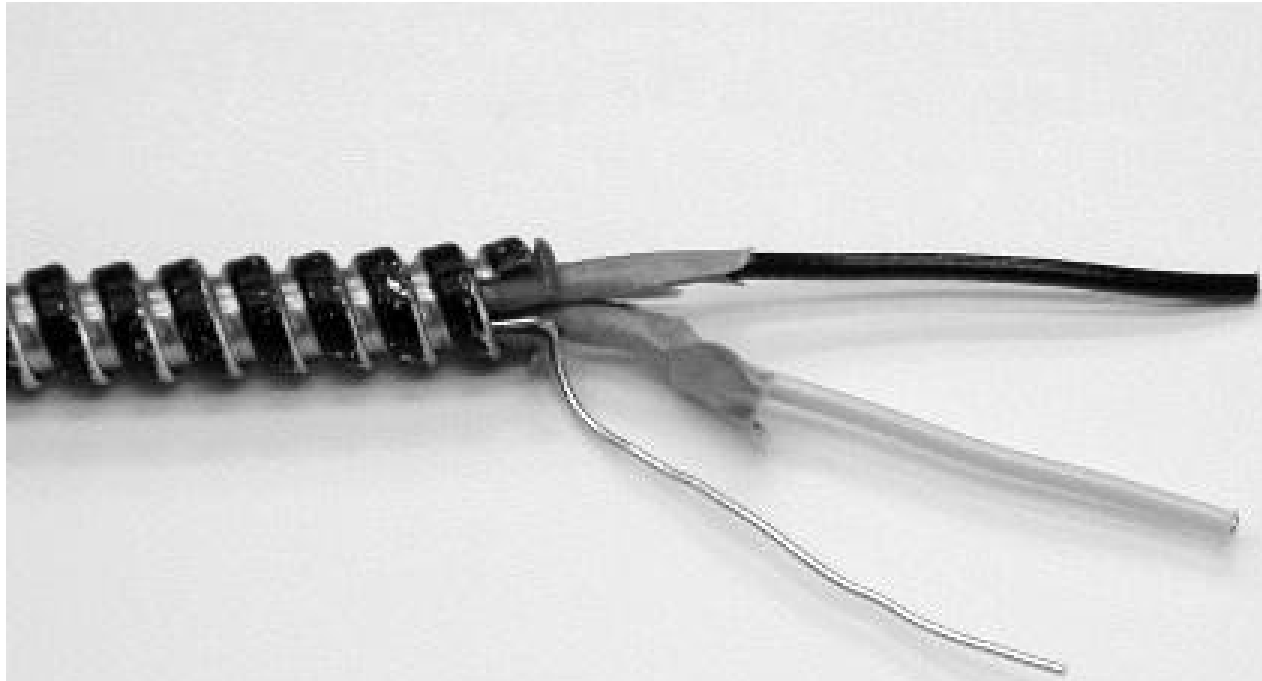
- ◆ Fire-stopping
- ◆ Fire-rated Assemblies
- ◆ Fishing
- ◆ Homerun
- ◆ Through-Penetration Fire Stop Systems

(It is not intended to repeat definitions from the NEC.)

3. Identification of Cables

◆3.1 Identification

Type MC and AC cables may look similar on their exterior (*Figure 3.1*). It is important that the proper cable be selected for installations where specific construction features or performance requirements are desired or are required in the NEC. Specific uses permitted and not permitted are identified in the following sections of this standard. Consult Table 1 for assistance in identifying cables.



Type AC
Cable



Type MC
Cable

Table 1: Identification of Type AC and MC Cables

	Type AC Cable	Interlocked Armor Type MC Cable
Number of Conductors	No more than 4 plus EGC.	No limit
Size of Conductors	14 AWG to 1 AWG	18 AWG to 2000 kcmil

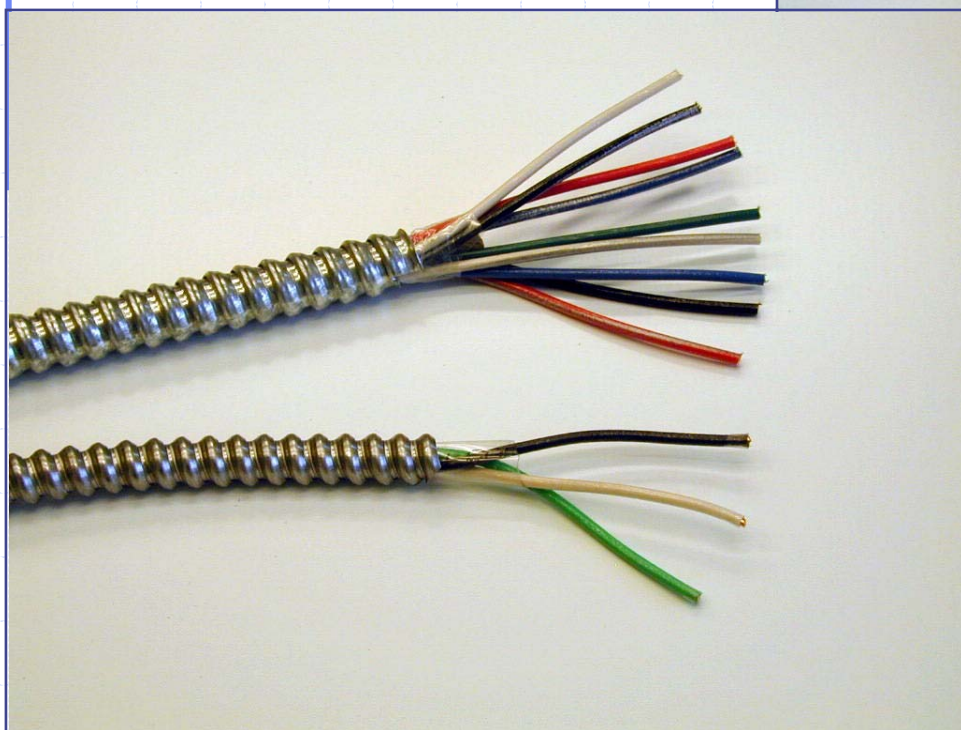
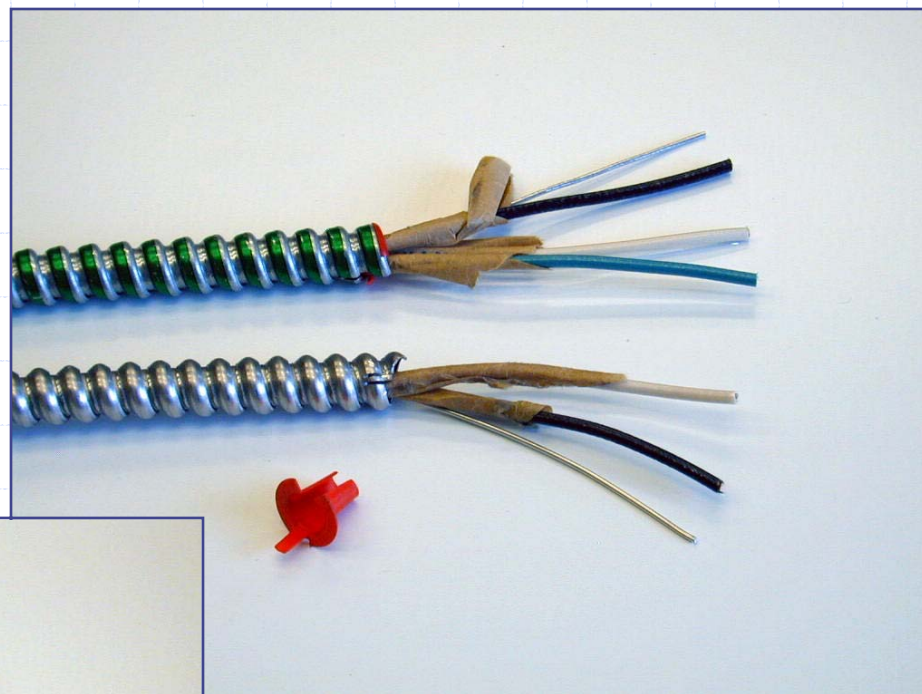
Table 1: Identification of Type AC and MC Cables

	Type AC Cable	Interlocked Armor Type MC Cable
Grounding	Has 16 AWG bond wire in constant contact with metal armor. Bond wire and armor together = EGC.	No bonding wire. The armor is not itself an EG. Internal EGC with armor = ground-fault path.

Table 1: Identification of Type AC and MC Cables

	Type AC Cable	Interlocked Armor Type MC Cable
Cable Construction	Individual conductors are wrapped in a moisture resistant, fire retardant paper.	Individual conductors are not wrapped. Conductor assembly has overall mylar wrap under the armor.

Type AC Cable

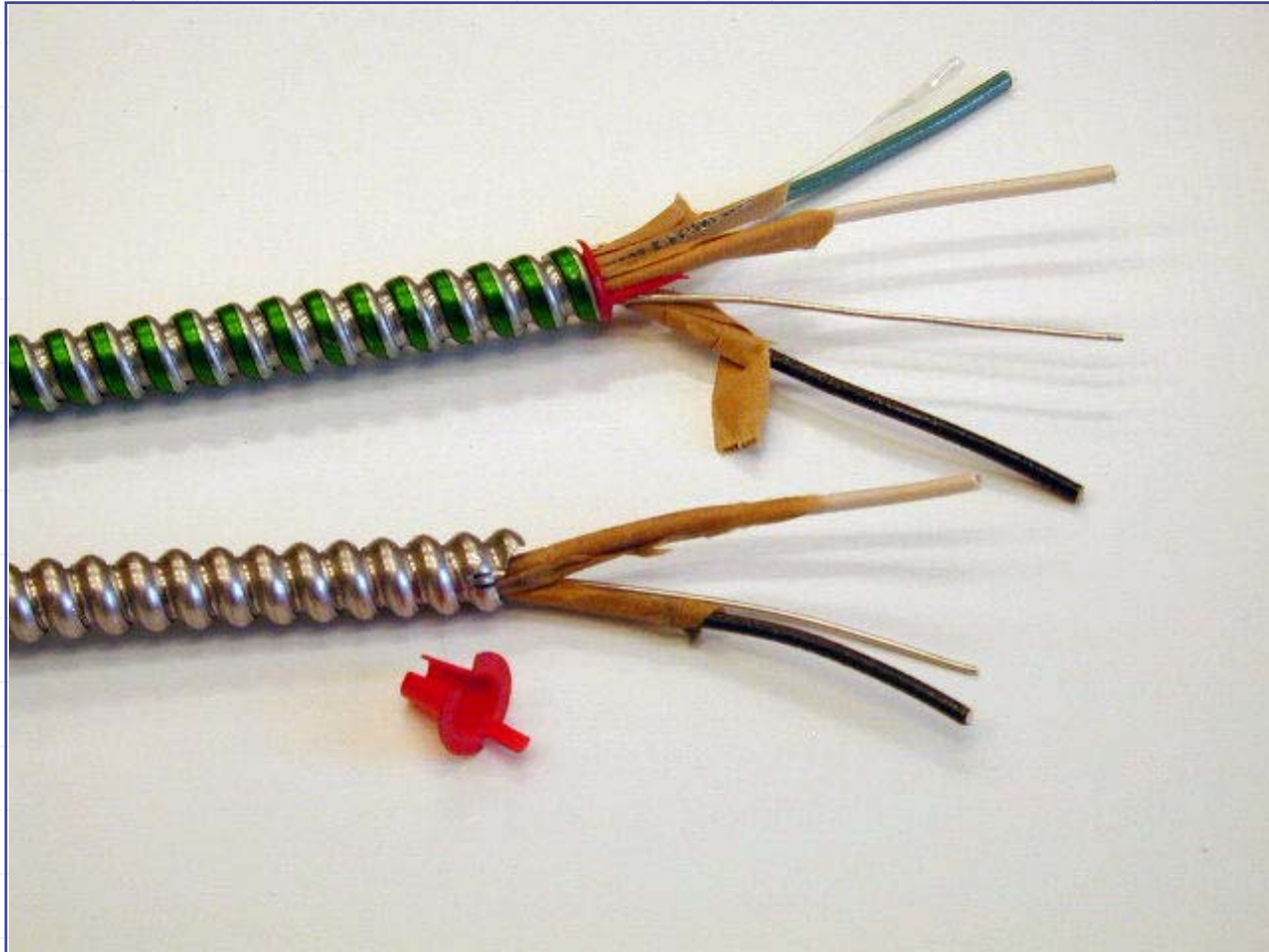


Type MC Cable

4.1 Description, Type AC Cable

- ◆ A factory assembly of insulated conductors in an overall sheath of aluminum or steel.
- ◆ Permitted have 2 to 4 conductors in sizes 14 through 1 AWG with or without an equipment grounding conductor
- ◆ All insulated conductors have an individual moisture-resistant fiber wrap
- ◆ Typical branch circuit cable have copper conductors with THHN insulation

Type AC Cable, Construction



4.2 Equipment Grounding, Type AC Cable

- ◆ A bare 16 AWG aluminum bonding strip is inside of and in intimate contact with the cable armor for full length of cable
- ◆ Outer armor with bonding strip is acceptable as an equipment grounding conductor
- ◆ Some AC cable has an insulated equipment grounding conductor. These cables are permitted in patient care areas of health care facilities and for isolated equipment grounding conductor installation

4.3 Uses Permitted, Type AC Cable

Where not subject to physical damage:	Without insulated equipment grounding conductor	With insulated equipment grounding conductor
In both exposed and concealed work	Yes	Yes

See page 5 for other Uses Permitted

4.3.1 Uses Permitted, Special Occupancies

Where not subject to physical damage:	Without insulated equipment grounding conductor	With insulated equipment grounding conductor
In Class I, Division 2 areas for nonincindive field wiring	Yes	Yes

See pages 5-6 for other Uses Permitted, Special Occupancies

4.4 Uses Not Permitted, Type AC Cable

- ◆ As service-entrance conductors
- ◆ Where subject to physical damage unless protected by conduit or tubing
- ◆ In damp or wet locations (see Article 100)
- ◆ In air voids of masonry block or tile walls where such walls are subject to excessive moisture or dampness
- ◆ Embedded in plaster finish on brick or other masonry in damp or wet locations

4.5 Connectors

- a) *AC cable connectors.* Fittings for connecting Type AC cable are required to be marked as suitable for such use. The identification is either on the smallest container in which the product is packaged or is on the connector itself.



4.5 Connectors

b) AC cable set-screw connectors.

Connectors of the set-screw type are only permitted to be used with cables having steel armor. They are not acceptable on cables with aluminum armor.

4.5 Connectors

c) *Other connectors.* Connectors for Type MC cable and power and control tray cable are also suitable for use with Type AC cable when specifically indicated on the connector or the shipping carton.

4.5 Connectors

d) *Insulating bushings.* Connectors or clamps that connect Type AC cable to boxes or cabinets are designed so the required insulating bushing is visible for inspection after the cable is connected. The insulating bushing is often referred to in trade jargon as a “red head.”

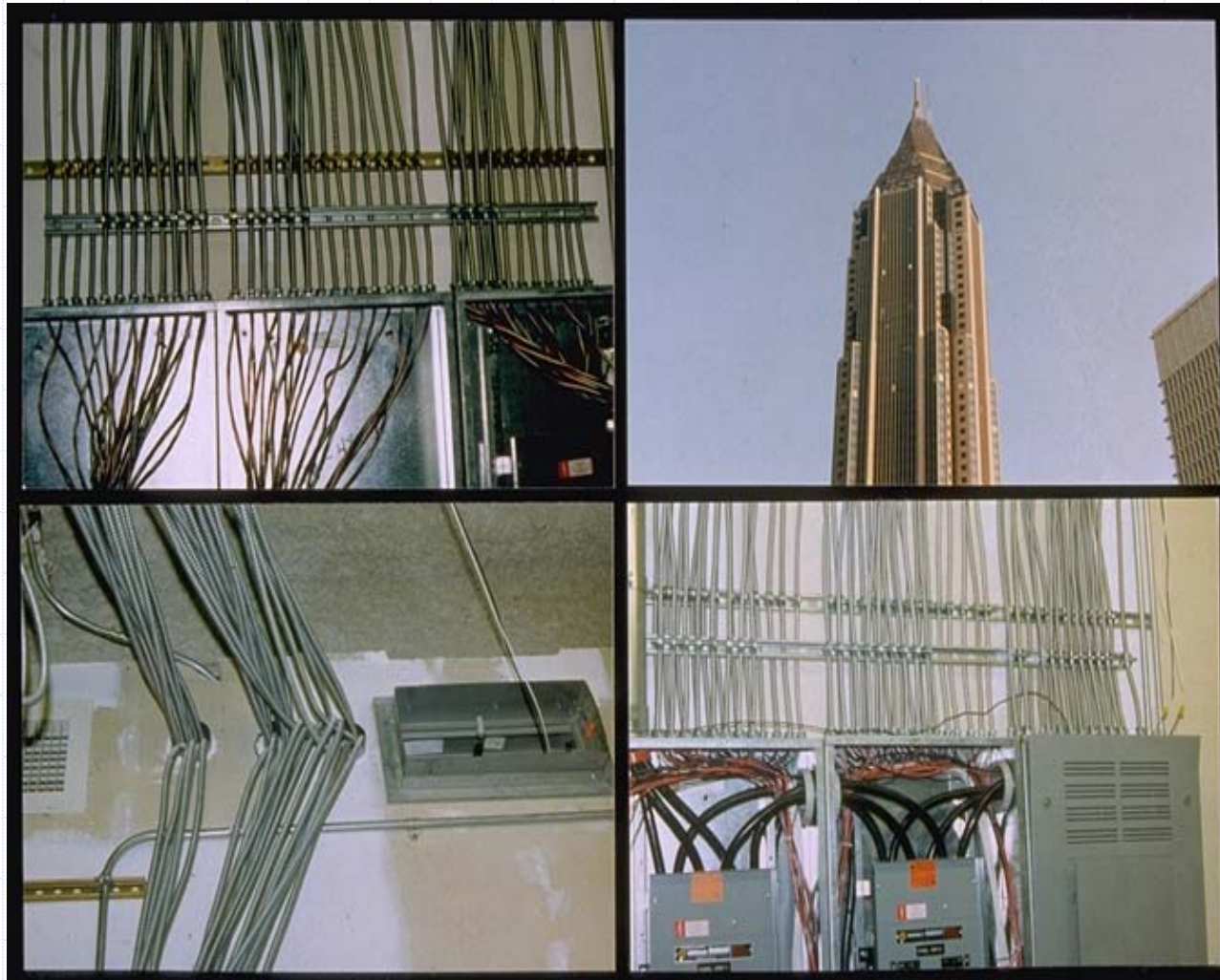
4.5 Connectors

e) *Grounding.* All listed connectors for Type AC cable are suitable for grounding since the armor of Type AC cable serves as the equipment grounding conductor. Remove paint or other insulating material between the enclosure and the connector to ensure a proper grounding connection.

More on Fittings for Type AC Cable

- ◆ See UL White or Green book (AWSX) for additional information
- ◆ Fittings for Type MC cable permitted to be used for Type AC where marked on the device or carton

5. Metal-Clad Cables (Type MC)



5.1 Description

- ◆ Type MC cable is a factory assembly of one or more current-carrying conductors and one or more equipment grounding conductors (if required) in an overall metallic sheath. MC cable is manufactured with three different types of armor:
 1. Interlocking metal-tape (steel or aluminum)
 2. Smooth (aluminum only)
 3. Corrugated (copper or aluminum)

5.1 Description

- ◆ MC cable consists of one or more current-carrying conductors, one or more equipment grounding conductors if required, and in some cases optical fibers. MC cables containing optical fibers are designated Type MC-OF and are considered composite cables in accordance with NEC Article 770.

5.2 Conductors

a) *Branch circuits.* MC cable contains conductors from 18 AWG through 2000 kcmil for copper and 12 AWG through 2000 kcmil for aluminum. Typical branch circuit Type MC cables have copper conductors with THHN, THHN/THWN or XHHW insulation and are suitable for circuits up to 600 volts.

5.2 Conductors

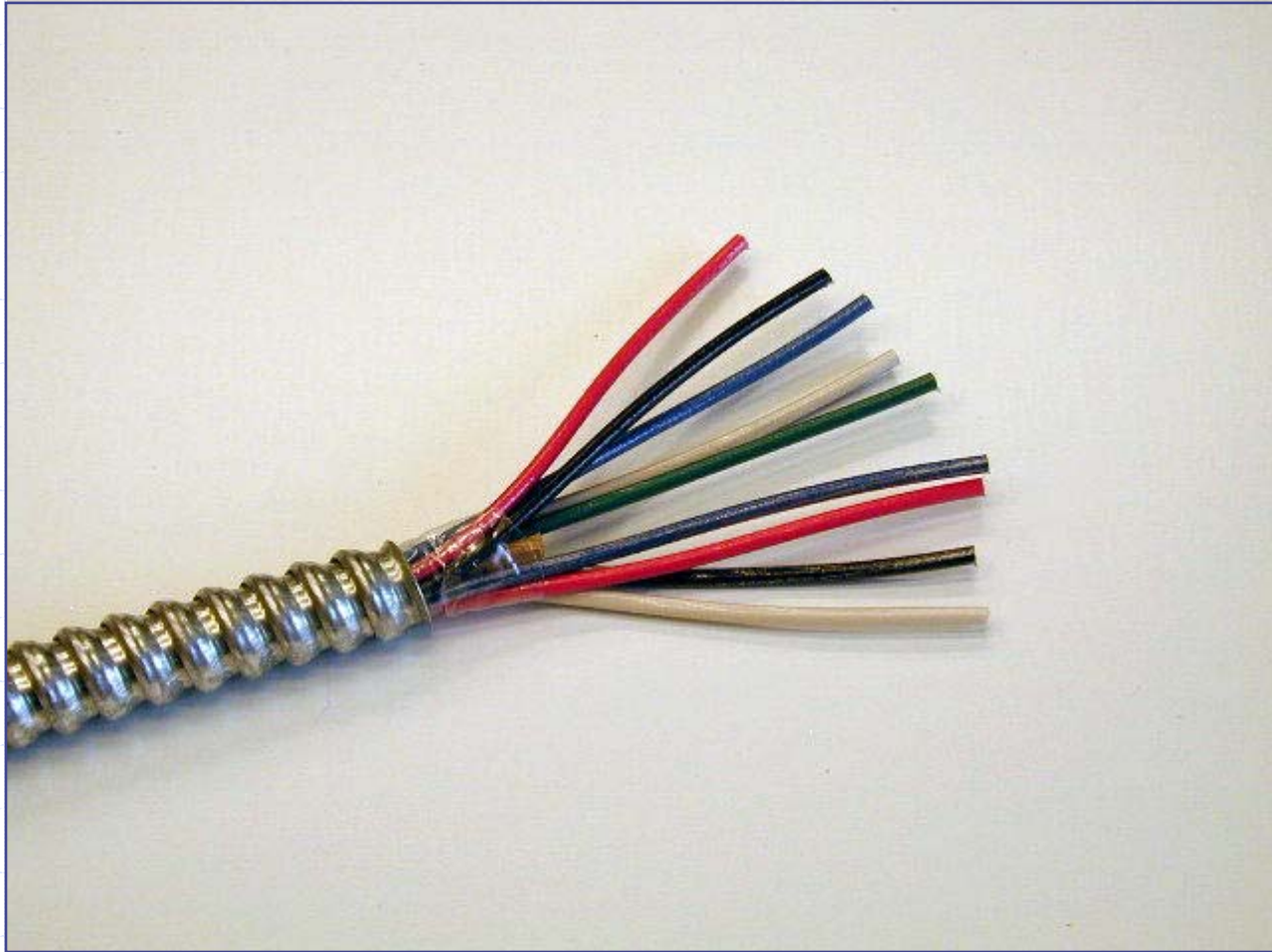
b) *Medium voltage.* Type MV cables are available with conductor insulations rated from 5,000 to 35,000 volts and may be marked for use as Type MC cables.

c) *Fire alarm.* Type MC cables intended for fire alarm/control applications have TFN, TFFN, THHN or other suitable insulation.

5.3 Special MC Cable Configurations

- a) *Fire Alarm***
- b) *Composite Cable***
- c) *Oversize neutral conductors***
- d) *Multiple individual neutral conductors***
- e) *Homerun***
- f) *PVC jacketed cable***

Multiple Neutral Conductors



PVC Jacketed Cable



5.4 Equipment Grounding

- ◆ ***5.4.1 Interlocking Metal Tape Sheath***
- ◆ The armor of Type MC Cable with an interlocking metal tape sheath is not itself suitable as an equipment grounding conductor. The cable includes an equipment grounding conductor which is either bare or insulated. For branch-circuit sizes, the most common type of equipment grounding conductor is insulated with an unstriped (solid) green color.

5.4 Equipment Grounding

a) Sectioned (larger feeder sizes)

- Multiple smaller equipment grounding conductors are installed to equal the size otherwise required in UL-1569

b) Isolated ground MC cables

- Have an additional equipment grounding conductor . Marked "IG"

c) Not in patient care areas

5.4.2 *Smooth or Corrugated Sheath Type MC Cable*

- ◆ The armor of MC cables with smooth or corrugated sheaths, or a combination of the sheath and a supplemental bare or unstriped green insulated conductor, is suitable for use as an equipment grounding conductor.
 - a) *Bare equipment grounding conductor or green insulation without a stripe.*
 - b) *Green insulated equipment grounding conductor with a yellow stripe.*

5.5 Uses Permitted

Where not subject to physical damage, Type MC cable is permitted to be installed as follows:	Comments:
For services	Comply with Article 230
For feeders	Comply with Articles 215 or 225

See pages 10-12 for Uses Permitted

5.6 Uses Not Permitted

Type MC cable is not permitted to be installed:	Comments:
Where exposed to corrosive fumes or vapors	Is permitted where the metallic sheath is suitable for the conditions ... such as a PVC jacket
Directly buried in the earth	Is permitted ... if listed and marked

See page 12 for Uses Not Permitted

5.7 Connectors

5.7.1. Criterion for Selecting

- a) The range of cable diameters
- b) Material of the sheath
- c) "Concrete-tight ..."
- d) "For Type MC Cable"
- e) "Dry locations ..."
- f) "Wet locations ..."

5.7.2 *Connector Identification*

- ◆ The identification is either on the connector itself or the smallest container in which the product is packaged.
- ◆ Connectors for Type MC cable, and for power and control tray cable, are also suitable for use with Type AC cable when specifically indicated on the connector or shipping carton.

5.7.3 Connector Size

- ◆ Select the appropriate size of cable connector for the dimension of the cable.
- ◆ The size of cable the connector is designed to terminate may be marked on the shipping carton.
- ◆ For some applications of jacketed Type MC cables, the diameter over the jacket must be considered
- ◆ Connectors are available for connecting two cables to one knockout.

5.7.4 Suitable for Type of Cable or Location

- a) Direct bearing set-screw connectors are suitable for only steel armor
- b) Aluminum connectors are suitable for only aluminum cables unless marked otherwise. Aluminum connectors are not permitted in concrete or cinder fill unless protected

5.7.4 Suitable for Type of Cable or Location

- c) Concrete-tight connectors should be used to secure PVC-jacketed MC cable embedded in concrete to boxes or other enclosures where the connections are covered in concrete
 - Some connectors are suitable for use on Jacketed Type MC cable only when taped. The packaging for these connectors will be marked "Concrete tight when taped when used with jacketed aluminum Type MC cable and jacketed steel Type MC cable."
- d) Wet-location connectors must be used for cable connections in wet locations

5.7.5 *Grounding*

- ◆ Listed connectors for use with corrugated aluminum or copper tube or smooth tube cable are suitable for grounding since the outer armor of these types of Type MC cable serves as the equipment grounding conductor. Remove paint or other insulating material between the enclosure and the connector to ensure a proper grounding connection.

6. General Installation Procedures

◆ 6.1 General Procedures

- ◆ In addition to complying with the specific installation requirements of the NEC, Type AC and Type MC cables are required to be installed in a “neat and workmanlike manner.” To the extent practicable, visible cables should be installed in vertical or horizontal lines or otherwise follow building lines. Cables must be supported properly where they are routed around obstacles as they are inherently flexible (Figure 6.1).



6.1 General Procedures

Condition	Type AC Cable	Type MC Cable
Exposed work according to the following three conditions:	Unless otherwise permitted, closely follow the surface of the building finish or running boards	No specific installation requirements

See pages 14-17 for General Installation Procedures

6.2 Installation of Homeruns

- ◆ *6.2.1 Planning*
- ◆ *6.2.2 Homerun Cables*
- ◆ *6.2.3 Phasing of Circuit Conductors*
- ◆ *6.2.4 Derating Conductors*
 - ◆ *6.2.4.1 When the Neutral Counts*

6.2.1 Planning

- ◆ Where panelboards are located in spaces where future access may be difficult, install spare cables to an accessible location.
- ◆ Identify locations by tags or other means.

6.2.2 Homerun Cables

- ◆ Available in a variety of conductors
 - 3-wires with ground
 - 4-wires with ground
 - 8-wires with ground
 - 12-wires with ground

6.2.3 Phasing of Circuit Conductors

- ◆ Connect multi-wire circuits properly in panelboards, junction boxes and at outlets
- ◆ One ungrounded conductor per phase and a common neutral

6.2.4 Derating Conductors

- ◆ Table 2 (Table 310.15(B)(2)(a) in the NEC) generally applies where the current-carrying conductors in cables exceeds 3 and the cables are bundled longer than 24 inches without maintaining spacing.

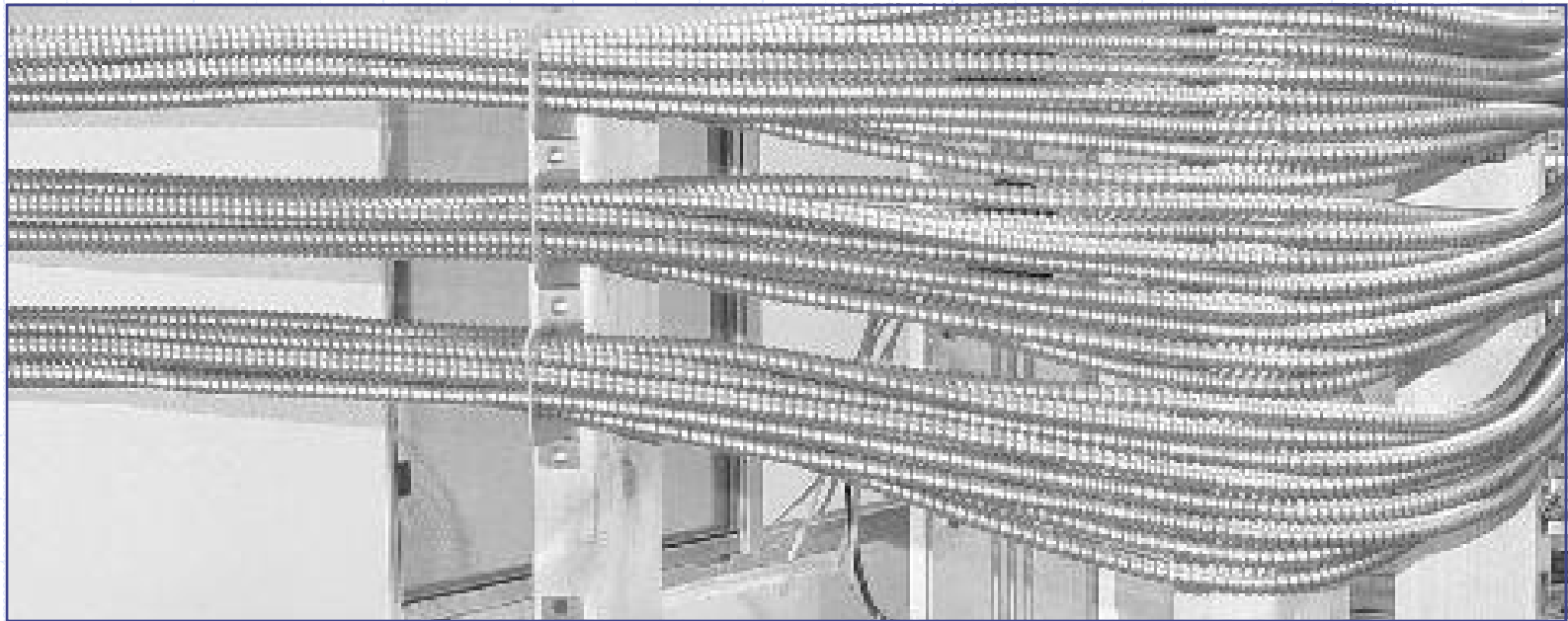
Table 2: Ampacity Reduction

No. of Conductors	Percent of Ampacity
4-6	80
7-9	70
10-20	50
21-30	45
31-40	40
41 and above	35

6.2.4 Derating Conductors

- ◆ Derating of Type AC and MC cables is not required where:
 - Each cable has not more than 3 current-carrying conductors
 - The circuit conductors are 12 AWG copper
 - Not more than 20 current-carrying conductors are bundled, stacked or supported on bridle rings
 - Derating to 60 percent of Table 310.16 allowable ampacities applies where more than 20 current-carrying conductors

Figure 6.2.4 Cable Supporter



Issues Related to Derating for Number of Conductors

- ◆ Determine the number of current-carrying conductors in branch circuits
- ◆ When do we have to count neutrals as current-carrying? [310.15(B)(4)]
- ◆ Apply rules of Table 310.15(B)(2)(a) when required
- ◆ Begin ampacity adjustment from 90 degree C column in Table 310.16 (THHN conductors)

Home Run Cable Example 1

- ◆ 8, 3-wire cables are installed longer than 24 in. and the neutral conductors are not considered to be current-carrying
- ◆ Derating is not required as the installation has 16 current-carrying conductors

Home Run Cable Example 2

- ◆ 8, 4-wire cables are bundled longer than 24 in. and the neutral conductors count as current-carrying
- ◆ 310.15(B)(2)(a) Exception 5 does not apply as there are 4 current-carrying conductors per cable
- ◆ Consider as 32 current-carrying conductors
- ◆ Apply adjustment factor from Table 310.15(B)(2)(a)
 - 40 percent (30 A [12 AWG, 90C] x .4 = 12 amperes)
- ◆ Consider increasing wire size or reducing number of conductors that are bundled.
- ◆ 10 AWG 40A (Table 310.16 90C) x .4 = 16 amperes

6.2.4.1 When the Neutral Counts

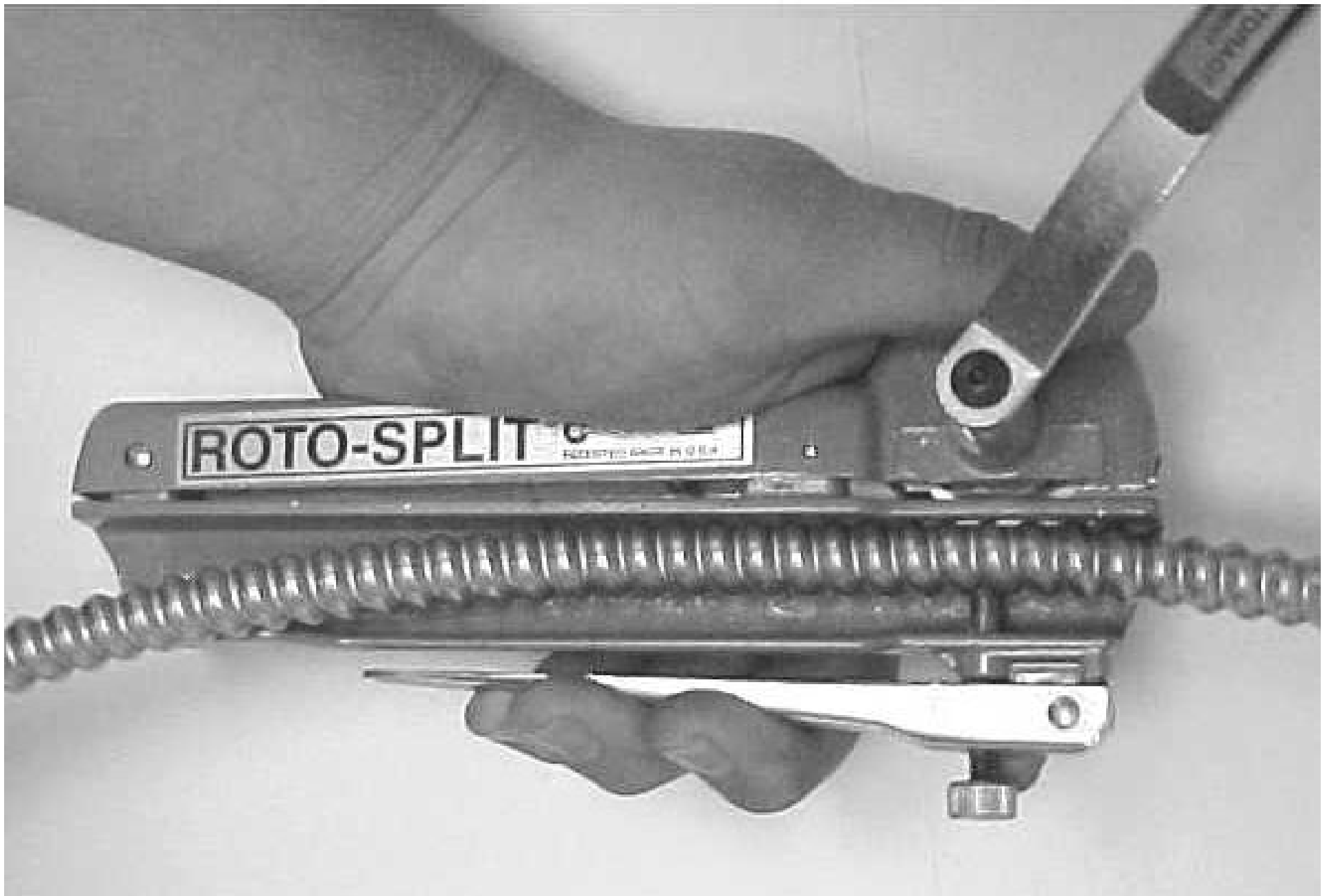
- ◆ When do we count the neutral?
 - 310.15(B)(4)(a). Don't have to count if it carries only the unbalance from other conductors
 - 310.15(B)(4)(b). Have to count in a 3-wire circuit from 4-wire, 3-phase wye system
 - 310.15(B)(4)(c). Have to count on 4-wire, 3-phase circuit where major portion of the load is nonlinear

6.3. Cutting AC and MC Cables

- ◆ 6.3.1 Rotary Armor Cutter
- ◆ 6.3.2 Hacksaw
- ◆ 6.3.3 Wire Cutters
- ◆ 6.3.4 Caution

6.3.1 Rotary Armor Cutter

- ◆ Designed specifically for safely cutting AC and MC cable armor
- ◆ Select appropriate rotary cutting tool
- ◆ Adjust anvil
- ◆ Cut armor
- ◆ Slide armor off cable



6.3.2 Hacksaw

- ◆ Cutting the armor of Type AC and MC cables with a hacksaw is not recommended
- ◆ Insulated conductors can be easily damaged

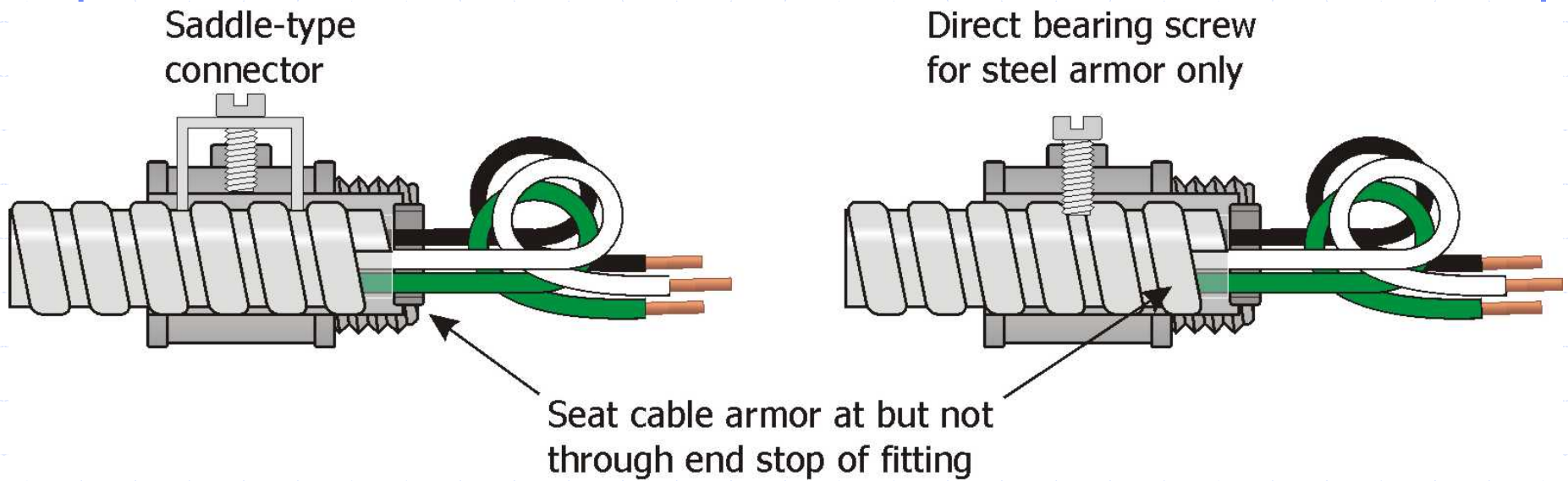
6.3.3 Wire Cutters

- ◆ Cutting the armor of Type AC and MC cables by “breaking” and use of diagonal pliers, tin snips or similar tool is not recommended
- ◆ Insulated conductors can be easily damaged

6.3.4 Caution

- ◆ Protect person's hands from sharp edges
- ◆ Protect insulated conductors from any sharp edge left from cutting operation

6.4 Position of Cable in Connector



6.5.1 Overcurrent Protection and Derating Type AC Cables

- ◆ Generally, select ampacity from Table 310.16
- ◆ Other rules include:
 - Overcurrent protection of small conductors in 240.4(D)
 - Derating where more than 3 current carrying conductors are bundled (see 20-conductor exception)

Table 6.5.1 OCP & Derating of Type AC Cables

Size	90°C Amps	Small Cndtr	≤ 20 wires	> 20 wires	Therm Ins
14	25	15	—	—	20
12	30	20	30	18	25
10	40	30	—	—	30

6.5.2 Type MC Cables

- ◆ Generally, select ampacity from Table 310.16
- ◆ Other rules include:
 - Overcurrent protection of small conductors in 240.4(D)
 - Derating where more than 3 current carrying conductors are bundled (see 20-conductor exception)

Table 6.5.2 OCP & Derating of Type MC Cables

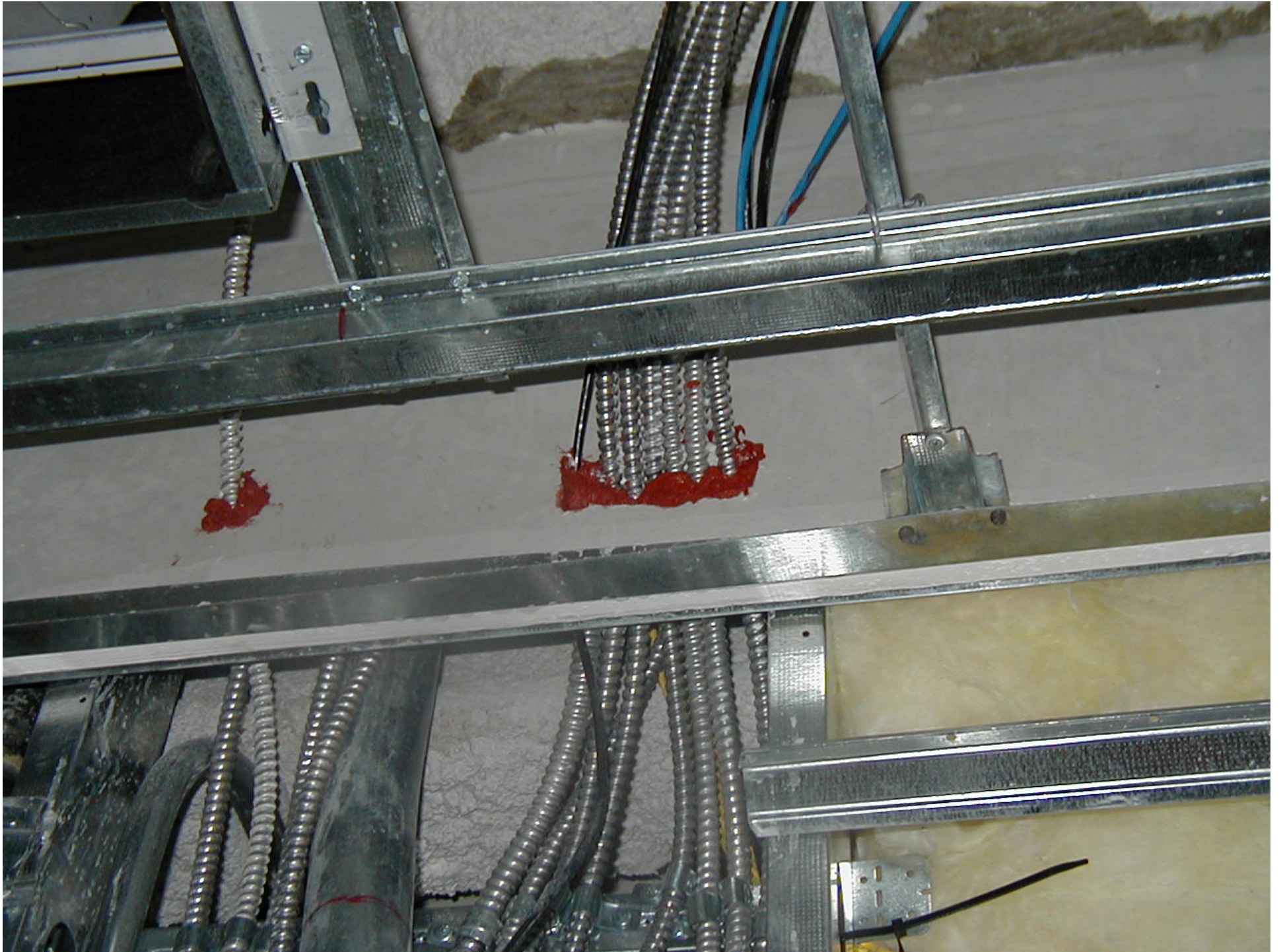
Size	90°C Amps	Small Cndtr	≤ 20 wires	> 20 wires
14	25	15	—	—
12	30	20	30	18
10	40	30	—	—

6.6 Fishing Cables

- ◆ Type AC and MC cables are well suited for fishing
- ◆ Carefully plan procedures keeping building construction methods in mind
- ◆ Access holes may have to be cut
- ◆ “Old work” boxes can be used to good advantage
- ◆ Caution on supporting lighting fixtures from “old work” boxes

6.7 Installing Cables Through Fire-Rated Members

- ◆ Walls, floors and ceilings at times have a fire-resistance rating
- ◆ Procedures must be followed so installation of cables does not reduce the rating.
- ◆ Various compounds or methods are available for sealing penetrations
- ◆ Fire-rated assemblies are classified in the UL Fire Resistance Directory



7.1 AC Cables, Boxes and Fittings

- ◆ Cable splices and terminations must be made in a box or other suitable fitting
- ◆ Connectors must protect conductors from abrasion.
- ◆ Fittings with direct-bearing screws are suitable for steel armor only
- ◆ Insulating bushings are required

7.2 Isolated Equipment Grounding

- ◆ Type AC cable with an insulated equipment grounding conductor is suitable for isolated grounding circuits
- ◆ Armor provides one path and insulated conductor provides the second
- ◆ Isolated equipment grounding conductor must be terminated properly

7.3 Health Care Facilities

- ◆ Two independent ground-fault return paths must be provided in patient care areas
 - One by wiring method
 - Second by insulated copper equipment grounding conductor
- ◆ Armor of Type AC cable provides the first path and insulated equipment grounding conductor provides the second path

7.3.1 Emergency Systems in Health Care Facilities

- ◆ Type AC cable is not generally permitted for emergency system circuits in facilities with critical care areas
- ◆ No similar rule for other health care facilities
- ◆ Type AC cables are permitted for emergency system wiring where:
 - Used in prefabricated medical headwalls
 - Used in listed office furnishings
 - Fished into existing walls or ceilings
 - Where necessary for flexible connections



Aluminum
bond wire

Black
insulated
wire

White
insulated
wire

Green insulated
wire

8.1 MC Cable, Boxes and Fittings

- ◆ Cable splices and terminations must be made in a box or other suitable fitting
- ◆ Connectors must protect conductors from abrasion.
- ◆ Fittings with direct-bearing screws are suitable for steel armor only
- ◆ Insulating bushings are not required

8.2 Isolated Equipment Grounding

- ◆ Type MC cable of smooth or corrugated armor type with an insulated equipment grounding conductor is suitable for isolated grounding circuits
- ◆ MC cable with spiral interlocked armor requires two insulated equipment grounding conductors
- ◆ Isolated equipment grounding conductor must be terminated properly

8.3 Health Care Facilities

- ◆ Two independent ground-fault return paths must be provided in patient care areas
 - One by wiring method
 - Second by insulated copper equipment grounding conductor
- ◆ Armor of the smooth tube or corrugated armor Type MC cable provides the first path and insulated equipment grounding conductor provides the second path

8.3.1 Emergency Systems in Health Care Facilities

- ◆ Type MC cable is not generally permitted for emergency system circuits in facilities with critical care areas or for circuits serving patient care areas
- ◆ Type MC cables are permitted for emergency system wiring where:
 - Used in prefabricated medical headwalls
 - Used in listed office furnishings
 - Fished into existing walls or ceilings
 - Where necessary for flexible connections

9. Type MC Cable in Hazardous (Classified) Locations

- ◆ 9.1 Class I Locations
- ◆ 9.2 Class II Locations
- ◆ 93 Seals in Hazardous (Classified) Locations

Table 5: Hazardous (Classified) Locations

Area or Occupancy	Area Classification	Type of MC Cable
In industrial establishments with restricted public access ...	Class I, Div. 1	MC-HL

See page 28 for Hazardous (Classified) Locations

For Additional Information

- ◆ www.nacmaonline.com
- ◆ Any NACMA member company

