Metal Clad Cable

By: Larry Watkins - Senior Field Applications Engineer, General Cable

Executive Summary

Metal clad (MC) cable can be found in almost every type of building under construction today. Stadiums, schools, multi-family homes, hotels, commercial retail and office facilities, industrial plants and warehouses are just the beginning of a long list of the types of projects where MC Cable is used.

Considering interlocked-armor MC Cable configured with (minimum) #8 copper and #6 aluminum conductors commonly used in 600 volt installations, this paper will examine the requirements, advantages and processes associated with using MC Cable in electrical projects.

MC Cable: A Technical Definition

The definition in Article 330 of the 2011 National Electrical Code® (NEC®(ANSI/NFPA 70 Standard) identifies MC Cable as a factory assembly of one or more insulated circuit conductors enclosed in an armor of interlocking metal tape, or smooth or corrugated metallic sheath.

It is important to differentiate between Type AC cable (armored cable) and what we are talking about here: Type MC Cable (metal clad cable). While the two may look very much alike, Type MC Cable includes an equipment grounding conductor whereas Type AC cable has an internal bonding strip in contact with the armor. MC Cable conductors may be as large as 2000 kcmil, while AC Cable is limited to size 1 AWG. Another important difference is that Type MC Cable may be rated for outdoor use and type AC cable is not suitable for outdoor use.

The NEC also articulates specific requirements for what constitutes acceptable fabrication of MC Cable. The equipment grounding conductor in a cable with interlocked metal tape sheath may be insulated or bare and may be sectioned. In cases where they are sectioned, all sections must be identical as stated in the UL standard. Further, the sheath of smooth or corrugated-tube MC Cable, or a combination of the sheath and a supplemental bare or unstriped green insulated conductor is suitable for use as a standard, required equipment grounding conductor. Any additional grounding conductors must have green insulation or green with yellow stripes.

The required equipment grounding conductor working in conjunction with the cable armor and connector (fitting) satisfy the rule for a low-impedance fault-return path. Working together, they provide a safe current flow path to the overcurrent protection device in the event of a ground-fault.

MC Cable employs thermoset or thermoplastic insulated conductors, and is permitted in the following sizes:

- 18 AWG through 2000 kcmil for copper, and
- 12 AWG through 2000 kcmil aluminum or copper-clad aluminum

Where and When to Use It

NEC Article 330 identifies permitted uses for MC Cable. Use in services, feeders, branch circuits, wet locations, and certain hazardous locations (such as Class I Division II) are just some of the applications listed by the code.

MC Cable is popular in large part because installation is generally considered to be more economical than pipe and wire installation – due mostly to the fact that the time-consuming process of installing conduits before pulling wire is eliminated.

Obviously, it is also important to determine the ampacity of MC Cable for a specific project. And for this, section 330.80 is helpful. It states that ampacity of 600 volt MC Cable must be in accordance with details outlined in section 310.15 of the NEC. As a rule, when there are no more that three current-carrying conductors per cable, the values in Table 310.15(B)(16) should be applied. If more than three current-carrying conductors are being used, derating is required. Correction factors apply for ambient temperatures above 30°C (86°F). The rooftop temperature adjustments in 310.15(B)(3)(c) do not apply to MC Cable.

Proper Installation

Prior to pulling MC Cable, the end must be prepared by stripping back the armor to expose the conductor. One way to strip the armor is to cut a ring around the cable with an armored-cable cutter. It is important to take care not to cut deep enough to damage the insulation on the conductors.

Another commonly used method is to cut two adjacent ribs of the armor with a rotary cutter or a hacksaw in order to slide the armor off.

After the conductor is exposed, a basket grip is placed over the conductor assembly and then the conductors, armor and basket are taped together. It is important to remember that, when pulling, force is to be applied to the conductors and not the armor.

Longer cable pull routes should be prepared by placing sheave wheels or pulleys at distances that will ensure the cable will pull properly and not be damaged in the process. Wheels or pulleys are not required for shorter pulls but smooth surfaces are. Pulling MC Cable over hard edges such as angle iron can result in damage to the armor.

For reassurance, UL 1569 metal-clad cable-testing requirements include a tension test of the armor. This test involves a 150 lb weight hanging from the armor for five minutes. To pass muster, the armor must not separate enough to expose the cable interior.

Proper cable support is also essential, and requirements are detailed in NEC Section 330.30. MC Cable must be supported and secured at intervals not exceeding 6 ft. (1.83 m). Appropriate supports include struts, trapezes, racks and cable trays. Generally, the same support systems used with metal conduit are used for MC Cable, with one notable difference: MC Cable installations require support at a maximum distance of 6 ft – not 10 ft as is required for most conduit installations. MC Cable can also be secured by the same assortment of clamps used to support conduit.

Also with regard to appropriate support mechanisms, MC Cable enjoys some leeway in situations where support structures are not practical. NEC Section 330.30(D) states, *"Type MC Cable shall be permitted to be unsupported where the cable is "...fished between access points through concealed spaces in finished buildings or structures and supporting is impractical..." It is also allowed to be unsupported for lengths up to six feet when used for luminaires"*.

Although cables are not specifically required to be supported according to the requirements in Table 300.19(A), it might be desirable to relieve the vertical weight of the conductors according to the distances in the table. Some methods might include clamps designed for compressing the armor and the subassembly, bending the cable to provide a horizontal component mid-run, or some other method. Section 300.19 requires that one cable support must be provided at the top of the vertical raceway or as close to the top as is practical, and this is a good idea for MC Cable installations as well.

One method of supporting and securing vertically run multi-conductor MC Cable is to install cables with 90-degree offsets at a minimum horizontal distance of two cable diameters. Here, it is important to remember that interlocked armor MC Cable bends must not exceed seven times the diameter of the cable.

Another method is to terminate the conductors, perhaps in a junction box, and start a new section of cable that continues on the vertical run. There are also clamps that are available to compress the armor and conductors to relieve the stress at appropriate intervals.

As noted, weight of the cable is an important factor here, and this is apparent in the difference in support requirements for copper conductors and aluminum conductors. Based on the same principle – the influence of gravity – the tightness of the fit of the armor to the conductors is also a significant consideration. In accordance with UL 1569 requirements, cables containing 4 AWG or larger conductors must pass a test in which a conductor within a vertically suspended 10 ft sample cable is attached to a 30 lb weight. To meet requirements, the conductor cannot displace more than one-half inch over a period of one minute.

One significant advantage of MC Cable is its versatility in terms of installation flexibility. MC Cable installations are easily identifiable by their lack of pull boxes. While conductors pulled in conduit are limited to no more than the equivalent of four quarter turns (360 degrees) between pull points, MC Cable has no restrictions on the number of bends. As mentioned previously, the bending requirement for interlocked armor MC Cable is "seven times the external diameter of the metallic sheath" as stated in Section 330.24(B) of the NEC. If you have a two-inch diameter MC Cable the radius of the curve of the inner edge of the bend shall not be less than 14 inches.

Having planned, pulled, supported and secured, it's time to terminate. Using the same process described earlier to remove MC Cable armor, remember to be careful not to damage the insulation on the conductors in preparation for termination. Next, we must ensure the selection of appropriate fittings.

A primary function of fittings is to provide a solid mechanical connection between the cable and the enclosure in order to ensure the armor is properly bonded. Section 330.40 requires that fittings used to connect MC Cable to boxes, cabinets, or other equipment shall be listed and identified for such use. A reason for this is that one of the major differences between fittings for Type AC cable and Type MC cable is that AC cable (as per Section 320.40) requires insulating (anti-short) bushings or an equivalent form of protection.

When terminating MC Cable, it is important to ensure there are no sharp edges in the fitting or armor that could damage the insulation on the conductors. The end of the armor should be squared to provide a flush fit with the end stop of the fitting.

In order to select the correctly sized fitting, it is important to know the dimensions of the MC Cable conductor assembly, the armor diameter, the fitting dimensions of the throat opening for the conductors and the clamping range for securing the MC Cable armor in the fitting. MC Cable has a polyester or paper wrap around the conductor assembly. Fittings listed for MC Cable by design may or may not include an insulating bushing. It is prudent for installers to note the instructions that accompany the fitting, and for them to be aware of whether or not a bushing is included. When manufacturers list fittings as being usable with both Type AC and Type MC Cable, this typically means a bushing is included with the fitting. In these cases, the installer should verify with the fitting manufacturer if the fitting was listed with or without the bushing for Type MC Cable. It never hurts to check with the fitting manufacturer and have a quick discussion around the suitability of using their fitting.

Proper Sizing

Section 330.108 states, *"Where Type MC Cable is used to provide an equipment grounding conductor, it shall comply with 250.118(10) and 250.122."* MC Cable comes with an insulated or bare equipment ground that is sized to protect the conductors in that cable. The standard equipment ground supplied for the particular MC Cable is not, in most cases, properly sized for multiple parallel runs of cable. Section 250.122 (F) addresses the requirement for properly sizing the equipment ground conductors for cables run in parallel.

Table 250.122 lists the minimum equipment ground size for the overcurrent device rating. Upon request, manufacturers of MC Cable do provide cables with larger equipment ground conductors. General Cable provides stock sizes suitable for use with a range of overcurrent devices.

Post-Installation: Identifying Type and Size

The installation and inspection of electrical components within an electrical system are critical to the performance of the system. When examining MC Cable installations, inspectors should note how the cables are handled, pulling setup, support methods, armor stripping techniques, locations installed, proper bending, and the use of appropriately sized, listed MC Cable fittings. It is important to observe everything within the context of the NEC, but to also pay close attention to local amendments. It always makes sense to check in with the local authority having jurisdiction.

As an inspector, it can be very difficult to identify conductor type and size after installation. With conduit-and-conductor installations you must look for cut-off conductor pieces or conductor remaining on reels. The same techniques are used with MC Cable. MC Cable information such as cable and conductor type, size and voltage is shown either on the marker tape included under the armor or on the conductors.

Conclusion

Type metal clad cable offers an economical, versatile approach to a wide array of construction projects. Distinguished from armored cable because it includes a grounding wire and can be used in outdoor applications, it also offers significant installation efficiency advantages over conductor-and-conduit applications – especially in terms of labor outlay. No conduits and no pull-boxes equate to easier installs with fewer materials in less time. All of these factors add up to an excellent option in a world that is increasingly looking for financial and resource efficiency.

References

NFPA 70®: National Electrical Code® (NEC®) 2011 Edition
Underwriters Laboratories Electrical Equipment Directory - 2008
NECA/AA 104-2006 ; Installing Aluminum Building Wire and Cable
NECA/NACMA 120-2006 Armored Cable (AC) and Metal-Clad Cable (MC)

General Cable

Three Ravinia Drive, Suite #1600
Atlanta, GA 30346
Tel (770) 394-9886 • Toll Free (855) 720-2792
www.stabiloy.com
Form No. BWWP-001-0114