Flammability Ratings for Balanced Copper Cables

Many end users understand the value of a consistent network cable infrastructure for their organizations. While this is often difficult enough to maintain across multiple sites in a single country or region, it can pose a much different challenge crossing international borders as companies expand globally. Once the performance (category 5e, 6, 6A, etc.) and construction (UTP, F/UTP, etc.) is selected, the next logical consideration that must be made on a site-by-site basis is the selection of cable jacketing requirements.

Today's cable jacket ratings for network cabling incorporate a wide range of terms, some of which may be more common than other depending upon location: CMX, CM, CMG, CMR, CMP, FT4, FT6 and LS0H. Each of these has a specific purpose and has an associated cost variance. The intent of this article is to provide a brief overview of each rating and the environments in which they are intended for use.

JACKET TYPES

In the United States, NFPA-70, the National Electric Code (NEC), specifies the environment where each cable type is to be used. In addition, each cable type has an associated recommended test method (for a detailed review of each test method, see Annex A).

- **CMP (PLENUM):**
  Suitable for use in ducts, plenums, and other spaces used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics. These cables are also referenced in Canadian Standards as CSA FT6.
- **CMR (RISER):**
  Suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.
- **CMG (GENERAL PURPOSE):**
  Suitable for general-purpose communications use, with the exception of risers and plenums, and shall also be listed as being resistant to the spread of fire. These cables are also referenced in Canadian Standards as CSA FT4.
- **CM (GENERAL PURPOSE):**
  Same as CMG (see above)
- **CMX (LIMITED USE):**
  Suitable for use in dwellings and for use in raceway and shall also be listed as being resistant to flame spread.

As the flammability and smoke requirements for cables become more stringent from CMX to CMP, the NEC also provides a cable substitution hierarchy (see Table 1) to allow the use of more stringent requirement cables in place of a less stringent cable. For example, a CMR or CMP cable could be substituted for a CM or CMG cable.

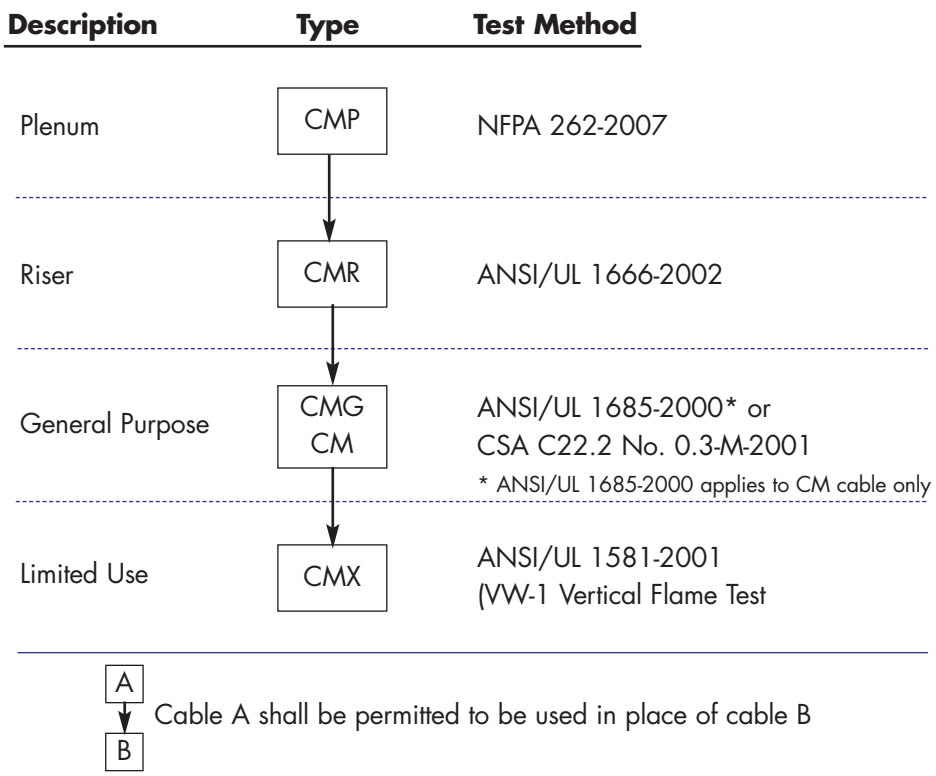

Figure 1: NEC Cable Substitution Hierarchy

Similarly, the Canadian Standard CSA C22.2 No.214 specifies the following substitutions:

- Communications cables marked CMP, CMR, CMG, CM, CMX, FT6, FT4 or FT4/1202 have been found to meet the standard criteria for FT1.
- Communications cables marked CMP, CMR, CMG, or FT6 have been found to meet the standard criteria for FT4 and FT4/1202.
- Communications cables marked CMP have been found to meet the standard criteria for FT6.

LS0H

In contrast to these jacket types is Low Smoke, Zero Halogen (LS0H or LSZH) cables. The advantages of this construction are a reduction of smoke, which can impair visibility, and the elimination of exposure by both personnel and active equipment to halogenated (acid) gases.

LS0H cables are typically subjected to a three distinct tests: flame retardency (IEC 60332), halogen content (IEC 60754) and smoke emission (IEC 61034). For flame retardency, there are two different grades: IEC 60332-2-2 (formerly IEC 60332-1) for a single cable and the more stringent IEC 60332-3-24 (formerly IEC 60332-3c) for bundled cables. Requirements for which grade is applicable varies by country and local codes should be consulted.

VARYING PHILOSOPHIES

At the heart of the issue, the purpose of having requirements for jacket ratings is for life safety. This is broken down into two primary considerations: flame spread and smoke generation.
Flame spread parameters are defined to impede the ignition and subsequent spread of flame. Smoke generation, while often less discussed, is equally important as its' corrosive nature, in the form of halogens, can damage sensitive equipment and are also toxic.

Generally, there are two primary historical schools of thought as it relates to jacket ratings. In the United States, jacket ratings consider the inhibition of flame spread as the greatest concern, but subsequently release dangerous halogen gases. In the European market, LS0H cables have primarily focused on the reduction of smoke and elimination of halogens, but have a lower resistance to ignition and flame spread.

It is not typically the choice of the end user to decide which philosophy may be better, but rather, because it is a life safety issue, it is national, regional or local codes that dictate the jacketing material that must be used.

HARMONIZATION OF STANDARDS

Unfortunately, the differences between NEC and LS0H ratings do not appear to harmonize any time soon. Additionally, as the testing methods for each are entirely different, there is no direct correlation between NEC and LS0H ratings. This often precludes the use of one cable in markets that specify the other.

While this difference is likely to remain in place for the indefinite future, there has been some consolidation on the NEC ratings as the reduced costs of CM cables has effectively eliminated CMX cables as they can be substituted as per the hierarchy at no additional cost.

SUMMARY

When it comes to selecting cable jacketing, the most important criteria is local codes, followed by regional or national requirements. These are hard requirements and are not open to interpretation. However, in some markets where such specifications do not exist, de facto options typically dictate the jacketing and are supported accordingly by local distribution. As in any case, the most important rule is to be well educated on the subject so that you can address any concerns that may arise.

ANNEX A - NEC COMMUNICATIONS CABLE TEST REQUIREMENTS

Rating	Reference	Definition	Test Requirements	FPN Notes
CMP	NEC 2008 Article 800.179 (A)	Type CMP communications plenum cable shall be listed as being suitable for use in ducts, plenums, and other spaces used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics.	NFPA 262-2007	One method of defining a cable that is low smoke-producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52m (5 ft) or less when tested in accordance with NFPA 262- 2007, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
CMR	NEC 2008 Article 800.179 (B)	Type CMR communications riser cable shall be listed as being suitable for use in a vertical run in a shaft or from floor to floor and shall also be listed as having fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.	ANSI/UL 1666-2002	One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2002, Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts.
CMG	NEC 2008 Article 800.179 (C)	Type CMG general-purpose communications cable shall be listed as being suitable for general-purpose communications use, with the exception of risers and plenums, and shall also be listed as being resistant to the spread of fire.	CSA C22.2 No. 0.3-M-2001	One method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5m (4 ft 11 in.) when performing the CSA Vertical Flame Test - Cables in Cable Trays, as described in CSA C22.2 No. 0.3-M-2001, Test Methods for Electrical Wires and Cables.
CM	NEC 2008 Article 800.179 (D)	Type CM communications cable shall be listed as being suitable for general-purpose communications use, with the exception of risers and plenums, and shall also be listed as being resistant to the spread of fire.	ANSI/UL 1685-2000 or CSA C22.2 No. 0.3-M-2001	One method of defining resistant to the spread of fire is that the cables do not spread fire to the top of the tray in the "UL Flame Exposure, Vertical Tray Test" in UL 1685-2000, Standard for Safety for Vertical-Tray Fire Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables. The smoke measurements in the test method are not applicable Another method of defining resistant to the spread of fire is for the damage (char length) not to exceed 1.5m (4 ft. 11 in.) when performing the CSA Vertical Flame Test - Cables in Cable Trays, as described in CSA C22.2 No. 0.3-M-2001, Test Methods for Electrical Wires and Cables.
CMX	NEC 2008 Article 800.179 (E)	Type CMX limited-use communications cable shall be listed as being suitable for use in dwellings and for use in raceway and shall also be listed as being resistant to flame spread.	ANSI/UL 1581-2001 (VW-1 Vertical Flame Test)	One method of determining that cable is resistant to flame spread is by testing the cable to the VW-1 (vertical-wire) flame test in ANSI/UL 1581-2001, Reference Standard for Electrical Wires, Cables and Flexible Cords.

ANNEX B - ASSOCIATED TEST METHODS

CSA C22.2 No. 0.3 *Clause 4.11.4 Vertical Flame Test - Cables in Cable Trays*

Intent: To determine flame propagation tendency of cables in a vertical tray.

Test: This test applies a 20 kW (~70k BTU/h) flame source to a cable attached to a vertically mounted ladder-type cable tray. The source is to be applied to the cable midway between rungs for a continuous period of 20 min. Following application of the flame, the cable fire (if any) will be allowed to extinguish.

Criteria: The evaluation for this test is the char length of the cable. It is measured from the location where the flame source is applied. This is a test method only and does not contain specific pass/fail criteria.
Note: A 1.5 m (4 ft. 11 in.) char length is required for CM and CMG cables per NFPA 70 (2005 NEC); CMG cables per CSA C22.2 No. 214; and FT4 cables per CSA C22.2 No. 0.3. Note that an alternate method for qualification of CM cables (only) per NFPA 70 (2005 NEC) is the UL 1581 Vertical-Tray Flame Test.

IEC 60754-2 *Determination of degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring pH and conductivity*

Intent: To specify a method for the determination of the degree of acidity of gases evolved during the combustion of compounds taken from the components of electric or optical cables.

Test: This test takes a 1000mg +/- 5mg sampling of the cable jacketing material and burns it in a tube furnace. The evolved gases are trapped by bubbling through distilled or demineralized bottles of water and the acidity is measured via the pH value. The conductivity of the solution is also measured.

Criteria:
•The weighted pH value should not be less than 4.3 when related to 1 liter (0.26 gal) of water
•The weighted value of conductivity should not exceed 10µs/mm

IEC 60332-1-2 *Test for Vertical Flame Propagation for a single insulated wire or cable – Procedure for a 1 kW Pre-Mixed Flame*

Intent: To determine the resistance to vertical flame propagation for a single vertical electrical insulated conductor or cable, or optical fibre cable, under fire conditions.

Test: This test applies a 1 kW (~ 3400 BTU/h) flame source for a duration of 60 sec to a single vertically positioned cable.

Criteria: After any associated burning has ceased, the cable must meet the following criteria:
• No charring can be present upward more than 425mm (~ 17 in.) from the source
• No charring can be present downward more than 65mm (~ 2.5 in.) below the source

IEC 60332-1-3 *Test for vertical flame propagation for a single insulated wire or cable – Procedure for determination of flaming droplets/particles*

Note: This testing may be performed simultaneously with IEC 60332-1-2.

Intent: To assess falling flaming droplets/particles when a single vertical electrical insulated conductor or cable, or optical fibre cable, is subjected to defined fire conditions.

Test: This test applies a 1 kW (~ 3400 BTU/h) flame source for a duration of 60 sec to a single vertically positioned cable.

Criteria: The cable must meet the following criteria:
• The cable cannot emits any particles that ignite filter paper located 150mm (~ 6 in.) below the source during the test duration.

IEC 60332-3-24 *Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*

Intent: To assess the vertical flame spread of vertically mounted bunched wires or cables, electrical or optical, under defined conditions.

Test: The test applies a [TBD kw/h] flame to a 3.5m (11.5 ft.) length of 300mm (11.6 in.) wide side-stacked line of cables attached to a vertically mounted ladder tray. The cable shall be allowed to burn or glow until cessation up to a maximum time of one hour, after which any remaining cable burning or glowing shall be extinguished.

Criteria: The maximum extent of the charred portion measured on the sample shall not have reached height exceeding 2.5m above the bottom edge of the burner.

IEC 61034-2 *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

Intent: To assess the density of smoke emitted from cables burning under defined conditions.

Test: This test applies a flame source comprised of an ignited tray filled with 1 liter (~ 34 oz.) of alcohol located 70mm (~ 3 in.) below 2-3 bundled cables positioned horizontally for a duration of 40 min or when there is no decrease in light transmittance for 5 min after the fire source has extinguished.

Criteria: The cable must meet the following criteria:
• A minimum of 60 % cable light transmittance must be recorded

NFPA 262 *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

Intent: To measure the flame travel distance (fire characteristics) and optical density of smoke (smoke characteristics) for cables that are to be installed in plenums and other spaces used to transport environmental air without being enclosed in raceways.

Test: This test applies a 86 kW (~294k BTU/h) flame source to a 1.37m (4.5 ft.) long side-stacked line of cables attached to a horizontally mounted ladder-type cable tray for a continuous period of 20 minutes.

Criteria: The cable must meet the following criteria:
• Maximum flame travel distance: 0.75m (2.5 ft.)
• Average optical density of smoke: 0.019m (0.63 ft.)
• Peak optical density of smoke: 0.33m (1.07 ft.).

UL 1581 *Section 1080 VW-1 (Vertical-Specimen) Flame Test*

Intent: A cable shall not convey flame along its length and shall not convey flame to combustible materials in its vicinity.

Test: This test applies a 500 W (1700 BTU/h) flame source at five 15 sec intervals to the 455mm (18 in.) single vertically positioned specimen. The period between applications is to be either 15 sec (if the cable flaming ceases of its own accord in less than 15 sec) or immediately following the period when the flaming ceases if longer than 15 sec.

Criteria:
• No more than 25% of the indicator, located 250mm (10 in.) from the source, can be burned away or charred
• The cable cannot continue to flame more than 60 sec after application of the flame source
• The cable cannot emits any particles that ignite a layer of cotton located 230-240mm (9-9.5 in.) below the source

UL 1581 *Section 1160 Vertical-Tray Flame Test (Note: This test simply references UL 1685)*

UL 1685 *Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*

Intent: To determine the values of cable damage height from electrical and optical-fiber cables in a vertical-tray when the cables are subjected to a flaming ignition source.

Test: This test applies a ~20 kW (70,000 BTU/h) flame source to a parallel line of cables filling the center 150mm (6 in.) of the entire length of the 2.44m (8.0 ft.) cable tray spaced one half cable diameter apart. The flame source is positioned 76.2mm (3.0 in.) from the cable for a continuous period of 20 minutes. Following the application of the flame source, the cable fire (if any) is to be allowed to burn itself out.

Criteria: The cable must meet the following criteria:
•The cable char height is to be less than 2.44m (8.0 ft.) when measured from the bottom of the cable tray.

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