



IDENTIFYING TRAY CABLES FOR YOUR NEXT INSTALLATION

A WHITE PAPER



Though rapidly increasing in popularity, tray cables are still a point of confusion for many. While the term “tray cable” is being heard everywhere, many do not understand what exactly a tray cable is or the benefits of using tray cables. Another gray area for many comes from the variety of types of tray cable, what each means and in which applications each type should be used. This paper will:

- Define what a tray cable is
- Describe the different types of tray cables
- Provide uses and standards for each type of tray cable

It will also provide a reference guide regarding the applications and governing standards for each tray cables type.

WHAT ARE TRAY CABLES?

As the name implies, tray cables are cables that can be used in many different types of cable tray systems, ranging from fixed wiring within buildings to hazardous locations and factory floors. According to the National Electrical Code (NEC) Article 392, there are many different varieties of cable trays, including ladder, ventilated trough, ventilated channel and solid bottom

trays among others. There are also other permitted uses which include raceways, such as aerial cables on a messenger, under raised floors in rooms containing industrial process control equipment and rack rooms. Tray cables are built to be flame retardant, offer safety and code compliance, and demonstrate adequate mechanical strength. Due to their many benefits, tray cables are becoming more frequently used in applications such as control rooms, tank farms, and in hazardous factory process applications.

If the cables pass stringent crush and impact tests they can carry the Exposed Run listing (ER), and may be used exposed when supported and protected. The National Electrical Code (NEC) has individual articles that define specific uses and installation practices. The articles reference cable types as defined by UL standards. NFPA 79, the National Fire Protection Association "Electrical Standard for Industrial Machinery" also establishes best practices for cabling on industrial machinery and often allows or requires use of tray cables. These serve as universal guidelines for the installation and best practices for using tray cables.

TYPES OF TRAY CABLES

600V Power and Control Tray Cable

Cables that are identified as Type TC are defined by UL 1277, and their use is governed by NEC Articles 336. Type TC (tray cables) are generally employed for power, lighting, control and signal circuits and are most commonly used on industrial machinery. As dictated by UL 1277 definition, the smallest American Wire Gauge (AWG) size allowed is 18AWG. All cables that are UL 1277 listed must first pass the UL 1685 Vertical Flame

Test or the FT4/IEEE1202 flame test. These are stringent flame tests, applying 70,000 BTU's from a 10" ribbon burner applied to cable in a vertical chamber for 20 minutes. The individual conductors inside the cable must also be UL listed to UL 44, UL 66 or UL 83, which is unique to 600V cables. The most common insulations include PVC, PVC with a nylon overcoat or XLPE. Both thermoplastic and thermoset outerjacket materials are allowed.

The insulation and jacket materials both determine the temperature listings of the cables. The most common jacket materials are PVC or TPE, which are thermoplastics. CPE and Neoprene rubbers can also be used. The highest rating available for thermoplastics and rubber is 90C Wet and 90C Dry. If the particular materials do not meet the requirements of 90C Wet and Dry, 75C Wet and Dry or 60C Wet and Dry approvals are possible. When these cables are used in environments with temperatures that exceed 90C, fluoropolymer jackets can be used which are allowed at 125C, 150C, or 200C. At the other end of the spectrum, Type TC cables may only be marked with a -40C cold temperature if they pass a -40C cold impact test.

Cables that are listed TC-ER pass stringent crush and impact tests, allowing them to be used in "Exposed Runs" when the rules of installation in NEC 336.10(7) and/or NFPA 79 are followed. Cables do not have to be installed in trays as long as they are mechanically protected with struts, angles or channels every 1.8m (6').

UL-Underwriters Laboratories

The UL, or Underwriters Laboratories Inc., is an independent product safety certification organization with five main areas of focus: product safety, environment, life and health, verification services, and knowledge services. UL primarily develops standardized test procedures and standards for products and materials with its main concentration on product safety. The UL was founded in 1894 and is approved to provide testing standards by the Occupational Safety and Health Administration (OSHA).

NEC- National Electric Code

The National Electric Code (also referred to as NFPA 70) is a standard ensuring the safe installation of electrical wiring and equipment. The NEC provides a standardized singular source to look for requirements for safe electrical installations. The NEC addresses the installation of electrical conductors, raceways, and equipment, signaling and communication conductors among many others. The NEC is not considered a law in the United States, though it is often mandated by local or state laws. The NEC was developed and is continually refined by the National Fire Protection Association (NFPA), was first published in 1897, and is updated every three years.



Industrial machinery often provides this protection, making TC-ER cables a cost effective choice. TC-ER listed cables also pass UL 1569 without the costly metal armor many cables need, providing increased flexibility and reduced costs.

As with all types and voltages of tray cables, the environment in which they will be used must be considered. Each standard defines tests which cables must pass if they are approved for expo-

sure to oil, used outdoors or exposed to UV. Cables used for direct burial must have the wording "direct burial" included in the legend of the cable jackets.

300V Power Limited Tray Cables

Type PLTC (Power Limited Tray Cables) cables are defined by UL 13 and governed by NEC Article 725. PLTC cables are built to stringent 300V requirements for Class 1, Class 2 and Class 3 remote control, signaling, and power-limited circuits. NFPA 79 also permits use of these listed cables on industrial equipment.

Type PLTC cables range in size from 12 to 22 AWG. Insulation types include PVC, SRPVC, PE's, TPE, some rubbers and fluoropolymers. Uniquely, this standard allows the use of foamed insulations which may be required for specific electrical performance. Jacket materials allowed include PVC, PE's, TPE's, cross linked polyolefins, neoprene, silicone and fluoropolymers.

Temperature ratings are determined by the properties of both the insulation and jacket materials. This standard allows temperature listings at 60C, 75C, 90C, 105C, 125C, 150C, 200C or 250C. Cold temperature listings may be marked on the cables if they pass cold bend testing at -20C, -30C, -40C, -50C, -60C or -70C. Cold bend testing is much less severe than cold impact testing which involves dropping metal onto the cables in cold temperatures. PLTC cables also must pass at least the UL 1685 Vertical Flame Test and may be labeled FT4/IEEE 1202 if they also pass these flame tests. All PLTC listed cables must also pass a UV resistance test and there are minimum tensile strength and elongation requirements.

PLTC cables may have a metal covering. Wire armor, metal braid, interlocked metal armor or a metal sheath are all acceptable so long as they meet the requirements in UL 13 Section 14. These metal coverings are used to enhance mechanical strength and also serve as

protection against rodents when needed.

As with the 600V Type TC cables, Type PLTC cables which meet the crush and impact tests of UL 1569, may be marked ER and used outside of tray or conduit when the installation practices in NEC Article 725.154(D) are observed. The UL 1569 tests are the same crush and impact tests used for metal clad cables, however these cables pass without the costly armor – allowing them to take up much less room. This also increases the cables flexibility and typically reduces the cost as well.

UL 13 has specific test requirements for each additional marking that may appear in the legend on the cable. These include oil resistance, low smoke and approval for direct burial use.





150V Instrumentation Tray Cable

The requirements for cables in UL 2250 ITC are almost identical to the requirements in UL 13 PLTC. These cables are built to 300V specifications but are intended for use in applications operating at 150V or less and 5 amps or less. The only major difference in the standards is ITC does not allow foamed insulations. ITC cables are commonly used in processing applications and are often a

good choice in hazardous locations.

Article 725 for Power Limited Circuit Cables is very long and fairly complex and requires Class 2 or Class 3 power supplies, etc. Article 727 Instrumentation Tray Cable is written to simplify installation practices for today's instrumentation and control networks which often require much less than 150V and sometimes only milliamps. ITC-ER cables

also pass the crush and impact tests of UL 1569 and may be used outside of trays when supported and protected in accordance with Article 727.4(5).

Other UL 13 CL Cables

Included in the UL 13 Power Limited Circuit Cables standard are cables with specific Class 2 or Class 3 listings which meet NEC Article 725. These cables are most often used as fixed wiring within buildings.

CL2P and CL3P cables are intended for use in ducts, plenums, or other air spaces. These cables must comply with the NFPA 262 test for Flame Travel and Smoke of Wire and Cable. CL2P allows 30 AWG to 6 AWG conductors and CL3P allows 28 AWG to 10 AWG conductors.

The 'R' in CL2R and CL3R cables denotes a riser. These cables are installed in vertical runs penetrating more than one floor or in a shaft. These cables must pass the UL 1666 Test for Flame Propagation Height. Gauges allowed are the same as for CL2P and CL3P cables.

CL2 or CL3 cables without any other designators are for use other than in plenums, risers or trays. These cables must comply with the UL 1685 and/or FT4/IEEE 1202 flame tests.

CL2X or CL3X cables have a much lesser flame test requirement, only that of UL VW-1. These cables have limited uses, limited lengths, and stringent protection requirements.

Communications Cables

Today, many factories desire to communicate data from the factory floor with the office. Since Ethernet is the network most commonly used in office environments it has naturally become the preferred network to transfer data from the factory floor to the office. This has increased due to the popularity of Industrial Ethernet which is most commonly covered under UL 444 Communications Cable. NEC Article 800 established and outlines installation practices.

Communications Cables employ the CM abbreviation, with a 'P', 'R', 'G' or 'X' affixed to the end signifying different types: CMP is Plenum, CMR is Riser, CMG is General Purpose, CM is also General Purpose with a few less requirements and CMX is Limited Use. The variables affixed to the end of 'CM' also indicate the severity of the flame test which dictates where they can be installed. CMP has the most stringent flame and smoke tests while CMX requires only the VW-1 flame test.

CONCLUSION

Understanding what tray cables are and the basics of the many types that are available is a good first step towards using them properly. This white paper has begun to detail the basics of each type of cable, how to differentiate them and where they are commonly used. It is always good practice to consult an expert before purchasing and installing tray cables to ensure the correct type of cable is properly used. The following reference guide lays out the uses and governing standards for each cable type defined throughout this paper in an easy-to-use format.

TC, TC-ER 600V

Cable Agency Approval	Cable Gauge	National Electric Code 2011 Compliance	Rules for Installation	Other Comments
<p>UL 1277 Electrical Power and Control Tray Cables</p> <p>Cables 600V</p> <p>Conductors are UL 44 or UL 83 Listed</p>	<p>18 AWG – 8 AWG</p>	<p>NEC Article 336</p> <p>Uses permitted:</p> <p>For power, lighting, control, and signal circuits.</p> <p>NFPA 79</p>	<p>Permitted in cable trays, raceways, in outdoor locations supported by a messenger wire, for Class 1 circuits as permitted in Parts II and III of NEC Article 725; for non-power-limited fire alarm circuits if conductors comply with the requirements of 760.49. NEC Article 336.10 (1) – (6).</p> <p>Cable must not be installed where it will be exposed to physical damage or outside a raceway or cable tray system unless it is outdoor in supported by a messenger wire or Type TC-ER (Article 336.12 Uses Not Permitted) Cables.</p>	<p>Type TC cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests.</p> <p>Cables which are sunlight resistant or intended for direct burial must be so marked.</p>
<p>UL 1277</p> <p>Cable must be labeled ER, signifying it meets the crush and impact requirements of Type MC cable, UL 1569</p>	<p>18 AWG – 8 AWG</p>	<p>NEC Article 336.10(7)</p> <p>NFPA 79</p>	<p>In industrial establishments where qualified persons service the installation. Cable is continuously supported and protected against physical damage using mechanical protection, such as struts, angles, or channels...permitted between a cable tray and the utilization equipment or device...secured at intervals not exceeding 1.8m (6').</p> <p>Permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8m (6') without continuous support.</p>	<p>Type TC cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests.</p> <p>Cables which are sunlight resistant or intended for direct burial must be so marked.</p>

TC

TC-ER

PLTC, PLTC-ER 300V

Cable Agency Approval	Cable Gauge	National Electric Code 2011 Compliance	Rules for Installation	Other Comments
<p>UL 13 Cable for non-plenum and non-riser Class 3 and Class 2 circuits in general and in trays. Cables are rated for 300V but are not so marked.</p>	<p>22-12 AWG</p>	<p>NEC Article 725 NFPA 79</p>	<p>Allowed in raceways (300.17) and Cable Trays (392). Article 725 is complex: read carefully for any specific application. Also allowed in Hazardous (Classified) Locations per Article 500-616 and Article 517 Part IV.</p>	<p>PLTC cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests. PLTC cables are sunlight resistant. Cable must be marked "direct burial" for such use.</p>
<p>UL 13 Exposed Run listing Cable must be labeled ER, signifying it meets the crush and impact requirements of Type MC cable, UL 1569</p>	<p>22-12 AWG</p>	<p>NEC Article 725.154(D) NFPA 79</p>	<p>In industrial establishments where qualified persons service the installation and where cable is continuously supported and protected against physical damage using mechanical protection, such as struts, angles, or channels...permitted between a cable tray and the utilization equipment or device...secured at intervals not exceeding 1.8m (6'). Permitted to transition between cable trays and between cable trays and utilization equipment or devices for a distance not to exceed 1.8m (6') without continuous support.</p>	<p>PLTC-ER cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests. PLTC-ER cables are sunlight resistant. Cable must be marked "direct burial" for such use.</p>

PLTC

PLTC-ER

ITC, ITC-ER 300V Cable, Intended for 150V or less and 5 Amperes or less

Cable Agency Approval	Cable Gauge	National Electric Code 2011 Compliance	Rules for Installation	Other Comments
<p>UL 2250 Cables are rated for 300V but are not so marked. Intended for use on circuits rated 150V or less and 5 amps or less.</p>	<p>22-12 AWG</p>	<p>NEC Article 727 NFPA 79</p>	<p>Permitted in industrial establishments where only qualified persons service the installation. Permitted in cable trays and raceways, also in hazardous locations per Article 501.10, 502.10, 503.10, 504.20, 504.30, 504.80 and 505.15. May be used as aerial cable on a messenger. May be used under raised floors in rooms containing industrial process control equipment and rack rooms where arranged to prevent damage to the cable and under raised floors in IT equipment rooms in accordance with 645.5(E)(5)(c)</p>	<p>ITC cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests. ITC cables are sunlight resistant. Cable must be marked "direct burial" for such use.</p>
<p>UL 2250 Exposed Run listing Cable must be labeled ER, signifying it meets the crush and impact requirements of Type MC cable, UL 1569</p>	<p>22-12 AWG</p>	<p>NEC Article 727, Especially 727.4(5) NFPA 79</p>	<p>In industrial establishments where qualified persons service the installation and where cable is continuously supported and protected against physical damage using mechanical protection, such as struts, angles, or channels...permitted between a cable tray and the utilization equipment or device...secured at intervals not exceeding 1.8m (6').</p>	<p>ITC-ER cables comply with UL 1685 and/or FT4/IEEE 1202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests. ITC-ER cables are sunlight resistant. Cable must be marked "direct burial" for such use.</p>

ITC

ITC-ER

CL3P, CL2P, CL3R, CL2R, CL3, CL2, CL3X, CL2X

Cable Agency Approval	Cable Gauge	National Electric Code 2011 Compliance	Rules for Installation	Other Comments
UL 13	CL3P 28-10 AWG CL2P 30- 6 AWG	NEC Article 725.154(A) 725.154(C) NFPA 262	For use in a duct, plenum, or other space used to transport environmental air. Permitted in cable trays installed indoors.	Cables comply with NFPA 262 Test for Flame Travel and Smoke of Wire and Cable. Cable exhibits a maximum flame-propagation distance not greater than 5' or 152cm, peak optical density of smoke produced of 0.50 or less (32% light transmission) and an average optical density of smoke produced of 0.15 or less.
UL 13	CL3R 28-10 AWG CL2R 20- 6 AWG	NEC Article 725.154(B) 725.154(C) UL 1666	Cables installed in vertical runs and penetrating more than one floor or vertical runs in a shaft. Must be used in listed riser signaling raceways and listed plenum signaling raceways. Permitted in cable trays installed indoors.	Cables comply with UL 1666 Test for Flame-Propagation Height of Cables Installed Vertically in Shafts. Flame propagation height < 12' or 366 cm and temperatures < 850F (454.4C) at a height of 12' or 366 cm.
For other than plenum, riser, or tray uses	CL3 28-10 AWG CL2 20- 6 AWG	NEC Article 725.154(B)(3) 725.154(C)	Permitted in one- and two- family dwellings. Raceway is not required but cables may be pulled into conduit or other raceway.	Cables comply with UL 1685 and/or FT4/IEEE 1 202 70,000 BTU/Hr. (20.5 kW) vertical-tray flame tests.
For Limited Use	CL3X 28-10 AWG CL2X 20- 6 AWG	NEC Article 725.154(B)(3) 725.154(C)	Must be used with protection such as a raceway. May be exposed in unconcealed spaces if cable does not exceed 10' or 3.05m.	Cables comply with UL VW-1 vertical-specimen flame test.

**CL3P
CL2P
Plenum
Cables**

**CL3R
CL2R
Riser
Cables**

**CL3
CL2
Com-
mercial
Cables**

**CL3X
CL2X
Cables**

CMP, CMR, CMG, CM, CMX

Cable Agency Approval	Cable Gauge	National Electric Code 2011 Compliance	Rules for Installation	Other Comments
UL 444		NEC Article 800 NFPA 262 Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces	See Table 800.154(a) NEC 2011	
UL 444		NEC Article 800 UL 1666 Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts	See Table 800.154(a) NEC 2011	
UL 444		NEC Article 800 CSA C22.2 No. 0.3M-2001 Vertical Flame Test – Cables in Cable Trays. Damage not to exceed 1.5m (4'11")	See Table 800.154(a) NEC 2011	
UL 444		NEC Article 800 UL 1685 Vertical Tray Fire Propagation and Smoke-Release Test	See Table 800.154(a) NEC 2011	
UL 444		NEC Article 800 VW-1 Flame Test UL 1581	See Table 800.154(a) NEC 2011	

**CMP
Plenum**

**CMR
Riser**

**CMG
General
Purpose**

**CM
General
Purpose**

**CMX
Limited
Use**