Just the Technical Facts

LSZH™ Industrial Cables are all cable tray-rated per IEEE-383 and ANSI/ICEA S-104-696, UL1277, UL13, UL444 and CSA C22.2 No. 230 and No. 232, a preferred tray-rating standard for industrial applications.

Tray-Rated Fiber Cables for Industrial Applications

Fiber Powers the Factory Floor

Today's industrial production environment is a digital environment. In industries ranging from auto manufacturing to chemicals to food and packaging, manufacturers are rethinking their plant operations and network capabilities. There is increasing use of automation to enable more flexible and efficient production. In addition, the factory floor is becoming more integrated into enterprise-wide business networks converging multiple networks on a single backbone.

These conditions, in turn, create new challenges for industrial systems designers and control engineers. One issue of concern is choosing the right communications cabling for the factory communications backbone. The digital factory floor depends on the quality, ruggedness and reliable operations of its communications backbone. If the network is down, and the line isn't running, the operation isn't making money. Engineers need to be certain that their cabling choices can stand up to the rigorous demands of a 24x7 production facility.

Copper cabling has been the traditional choice for these industrial applications, and there is a range of industry standards – typically referred to as "tray-rating" – for certifying the performance of copper cable for industrial use. However, fiber optic cable is rapidly becoming a viable and proven industrial cabling option, with features and inherent advantages that make fiber a strong candidate for inclusion in industrial solutions. Corning Cable Systems Industrial Solutions are built around fiber optic cable that has been tested and proven to meet, and exceed, the robust, reliable performance standards that control engineers need for their systems.

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LANscape® Solutions

Cable Tray Ratings: Why Do They Matter?

Industrial settings, no matter how sterile or well-insulated, feature conditions that can place harsh demands on electronic communications. Vibration, electromagnetic and radio frequency interference, moisture,

extreme temperature changes and other indoor/outdoor environmental conditions can degrade or disrupt the stability and long-term usefulness of communications cables.

Industry trade groups developed the NEC, National Electric Code (also known as NFPA 70) to set standards for the safe installation and use of electrical wiring. A key component of these standards for industrial applications is a communication cable's tray-rating, which evaluates and certifies the mechanical performance of the cable carried in an open tray and specifically, the resistance of the cable jacket in that setting to:

- Extremes of heat and cold, over time
- Material degradation due to sunlight exposure
- Impact resistance
- Pressure resistance
- Oil and water infiltration resistance

To obtain the NEC tray-rating, cables are subject to standard tests designed to simulate long-term environmental and usage impacts on the cable jacket that can degrade the jacket's integrity. Primarily, this is done for safety reasons – to prevent shock, short circuits or electrical fire risks from split or broken electrical cables. Being exposed in cable trays increases this risk, compared to cabling that is enclosed. Many industrial machines and settings require communications cables that are tray-rated; this protects plant personnel and property and establishes standard criteria for cable usage in exposed trays.

In addition, many engineers will specify tray-rated cables for their system designs, since the certification ensures reliable, predictable performance over the machine's effective lifetime. Cables that are tray-rated do not need to be encased in more expensive conduits. This feature minimizes costs for both system equipment and installation, making it easier to upgrade or add additional network elements, since the communications cabling is readily accessible.

Tray-Ratings For Fiber Optic Cable: What Are The Concerns?

Current testing and standards in NFPA 70 for cable tray-rating were established and are maintained for copper cabling – essentially, this standard has been created for cabling carrying electrical current. With the rapid advent of fiber cabling for industrial use – replacing electrical current with laser light – there has not been sufficient time or investment to develop a parallel set of fiber "tray-rating" criteria.

NFPA 70, Article 770, briefly addresses fiber cabling by simply stating, "Fiber cables shall be permitted to be installed in cable trays." There are no specific tray-rating testing and evaluation criteria for fiber. In addition, control and electrical engineers are reluctant (or unable) to specify fiber cabling that does not specifically state tray-rating, a standard they have relied upon for decades while using copper cables.

Some fiber cabling manufacturers cite compliance to IEEE 383, a different fire resistance standard for fiber cabling run in trays; however, this is for fire resistance only and has been established specifically for fiber cabling used in nuclear power plants. It does not address other performance criteria such as mechanical damage and weathering resistance, so it cannot be considered analogous to NFPA 70.

To help clarify the tray-rating issue for fiber optic cabling in industrial settings, Corning Cable Systems takes a more comprehensive approach. All Corning Cable Systems Low-Smoke/Zero-Halogen™ (LSZH) Industrial Solutions have been independently tested to meet or exceed the requirements for tray-rated copper cabling with reliable and rugged performance.

By independently certifying its LANscape® Solutions Industrial Fiber Optic Cables for tray use, Corning Cable Systems is making it possible for process and control engineers to add the inherent advantages of fiber communications to their industrial communications backbone with the verified tray-rating reliability they count on.

Just the Technical Facts

Tray-Rated Fiber Cables for Industrial Applications

Industrial Cabling: Fiber vs. Copper – How Do You Choose?

There are currently two viable media cable types proven for use in tray carriers in industrial settings: copper cabling and fiber optics. There are a set of common criteria most engineers and system designers should consider to evaluate the best solution for their application. Although copper has long been the "default" solution for industrial communications backbones, fiber optics offers industrial networks significant advantages in the following key areas:

Communications Stability

The growing use of complex automation and control technologies and communications protocols – Industrial Ethernet, SERCOS III, for example – means that production systems are much more dependent on the quality and integrity of the data stream throughout a production line or facility. Engineers need to ask: what risks of interference in data stream exist?

Copper cabling limitations include:

- **Sensitivity to machine electrical noise** The sensitivity includes electric motors, drives and the growing use of integrated and distributed electronic control and sensor components in pneumatic and hydraulic systems. Since cable trays carrying copper often pass very near or directly over these components, they can create burst of interference that can disrupt communications; in some very sensitive processing environments (chemical processing or oil refining), this interference may trip quality thresholds that lead to costly and time-consuming automatic shutdowns and restarts.

- **Noise from grounding** Being metallic, all copper cables need to be grounded at each termination point; this creates a second source of potential electric noise that can be time-consuming to isolate and correct.

- **Radio frequency (RF)/wireless interference** As the industrial world becomes more digital, it is also becoming more wireless. The growing use of wireless PDAs, cellular devices, handheld operator terminals – even wireless security cameras – creates a more complex RF environment on the factory floor. There is evidence that some tray-rated copper cabling solutions experience interference from these sources as well.

The advantages of fiber optics are well-proven and inherent:

- **Noise-free** Electronic noise, no matter how powerful, cannot disrupt light, assuring control engineers of extremely high-quality throughput

- **Ability to avoid grounding requirements** The glass of fiber optics is non-conductive and cabling technologies like those Corning Cable Systems has developed for industrial applications provide extreme crush and impact resistance without introducing conductive armoring into the cable that would require grounding. Even when selecting an armored fiber optic cable, grounding can be done without any risk of introducing noise onto the transmission medium – the fiber.

Usability

Along with stability, design engineers should consider how well both fiber and copper serve the core communications functionality required for industrial settings. Copper is a time-proven cabling solution and most designers understand and are familiar with its performance in this role. In comparison with fiber optics, however, copper cabling is subject to certain and potentially growing limitations:

- **Distance** Copper cable runs have upper distance limitations; this leads to one of two potential complications for large-scale installations. The first complication is time-consuming design workarounds when communications backbone requirements exceed those limits. The second complication is designing in additional components, such as signal regenerators/repeaters. These are added circuit elements that are potential points of failure and need to be added to the cost of the cabling solution.

Just the Technical Facts

Tray-Rated Fiber Cables for Industrial Applications

- **Installation** For tight machine spaces, copper cabling has less tensile strength and a larger bend radius compared to fiber (Table 1), potentially limiting its use. In addition, recent trends show copper connectivity has significantly increased in price, while simultaneously becoming more expensive and difficult to install with each successive generation (for example, jacks are far more complex to install on Category 6 copper cables than previous categories).

Table 1

10 GbE Twisted-Pair Copper Cabling

Cable	Maximum Diameter (in)	Bend Radius
Category 6	0.25	4 x OD
Category 6A	0.35	4 x OD
Category 6 F/UTP	0.35	4 x OD
Category 7 S/FTP	0.35	4 x OD

Note: Typcial Bend Diameter for Fiber: 10x OD installed, 15x OD loaded. Dielectric cables up to 288F ≤ 1.0 inch diameter

By comparison, fiber is a technology that has been deployed for decades in communications networks worldwide and offers advantages particularly well-suited to operational and machine design requirements for industrial applications.

- **Ease of use** Fiber has become much easier and simpler to design and install than in the past. It gets easier with each iteration of termination technology rather than more difficult. Fiber optic cabling solutions can be deployed in an industrial network up to 50 percent faster than legacy methods.

- **Distance** Fiber offers large-scale installations much longer cable runs compared to copper; for example, Corning Cable Systems Industrial Solutions Fiber Optic Cables are guaranteed to provide 1 Gigabit Ethernet throughput for at least 1000 meters, so no repeaters or amplifiers are needed.

Cost Factors

A critical measurement for most industrial system designs is Total Cost of Ownership (TCO). Today's industrial marketplace presents some lifecycle costs that impact copper's long-term value compared to fiber.

Copper cost considerations include:

- **Global demand** Like many commodities, copper's cost has been fluctuating significantly, making it harder to accurately project its cost, although the long-term trend in basic commodities is up.

- **Throughput** Inherent bandwidth limitations could be a long-term roadblock, as next-generation industrial networks need to support high, real-time data transfer, forcing additional bandwidth capacity and adding to TCO.

Fiber optic cabling costs are trending in the opposite direction from copper:

- **Lower materials cost** Fiber prices are relatively stable and opto-electronics as a whole have become much more cost effective.

- **Lower maintenance** Fiber optic cabling requires fewer upgrades and less maintenance; for example, a single generation of optical fiber can outlast six generations of unshielded twisted-pair copper cable.

How Do You Evaluate Fiber Optic Cabling Options?

If you've determined that fiber technology provides the right solution for your manufacturing operation's communications backbone, you then need to consider which solution provides the best fit. There are a number of fiber optic suppliers offering cabling for industrial applications; systems designers should assess the following criteria:

Tested for Tray-Rating

Most fiber optic cable has only been subjected to the IEEE 383 fire test standard, which is only one factor to consider for cable suited for carrier tray use. It does not take into account long-term environmental or mechanical conditions that are typically encountered in industrial

settings. It is important to carefully evaluate a fiber optic cable's specifications to ensure that it has actually been tested to NFPA 70 tray-rating guidelines. Fiber optic cable that simply refers to itself as "tray-rated" may only be referring to the NFPA's guidance that "Fiber cables shall be permitted to be installed in cable trays." If you want the reliability of a tray-rated cable, make sure the cable has actually been verified as meeting those standards.

Using the NFPA 70 as a guideline, since no NFPA 70 fiber optic test for tray-rating exists, Corning Cable Systems rigorously tested its LZSH™ Industrial Fiber Optic Cables to meet a broad range of performance standards for industrial applications. Using an independent testing authority, the cables were tested for:

- Impacts under abnormal low temperatures
- Mechanical impact and mechanical crush damage
- Cold bend cracking damage
- External weathering
- Oil resistance

For each test, Corning Cable Systems Industrial Solutions Fiber Optic Cables met or exceeded the same standards for being considered tray-rated that have been established for copper cabling.

Life-Safety Characteristics

Safety is a paramount issue for industrial settings, so materials and systems utilized in these environments should always incorporate features that protect personnel in the event of an emergency. For fiber optic cables, this should include jacket materials that do not pose an environmental hazard if they should be subject to fire. Corning Cable Systems offers a broad portfolio of industrial cables that are certified low-smoke, zero halogen. Unlike some industrial cables, Corning Cable Systems LSZH Cables contain no halogen, which can form a noxious vapor if superheated. If this halogen-based vapor comes in contact with water, it can form an acid that is harmful to both personnel and equipment.

In addition, Corning's LSZH cables burn to ash in the rare event they are ignited, eliminating a source of secondary fires.

Engineered for Industrial Environments

Fiber communications technology was originally developed for telecommunications applications. Some manufacturers have simply adapted their telecom fiber offerings with minimal modifications for industrial use, rather than engineering them from the ground up for rugged, demanding industrial conditions.

Based upon proven stranded loose tube cable designs, Corning Cable Systems Industrial Cables were specifically designed for the unique requirements of industrial applications. This approach includes:

- A higher fiber count per cable for greater flexibility from 12 to 288 fibers
- One product set for both indoor and outdoor applications to provide a single resource for an entire facility's needs
- Multiple cable jacket types created to meet specific needs:
  - Industrial LSZH
  - Industrial LSZH Cold Temperature
  - Industrial LSZH Corrugated Armor
  - Industrial LSZH Interlocking Armor
  - Flame-rated OFN per NEC
  - Sunlight resistance, able to be direct-buried
- Special print to designate tray-rated (Example: CORNING OPTICAL CABLE – 02/08 – Handset – 12 SME – INDUS-TRAY SUN RES DIR BUR – LSZH – OFC-LS FT4-ST1 c(ETL) us 01186 FEET)

Complete Solution

Industrial communications backbones consist of more than just the fiber cable; the best solutions offer a complete set of system components engineered and integrated to be designed, installed and operated together.

Just the Technical Facts

Tray-Rated Fiber Cables for Industrial Applications

Corning Cable Systems Industrial Solutions meet the definition of "solution." Beyond our high-performance, tested-tough cable, we offer a complete package of industrial connectors, hardware and installation equipment, supported by some of the most experienced fiber optics engineering experts in the world. This gives industrial designers a reliable single source for all industrial local area network components, saving time and simplifying system specification, purchasing and maintenance.

In addition, all Corning Cable Systems Industrial Solutions include only Corning® optical fiber – from the inventors and the world's largest provider of fiber optics, for additional assurance of quality and performance.

Tray-Rated Fiber Cabling – Making the Best Choice

While fiber optic cabling currently has no formal standard similar to the elements in NFPA 70 related to tray-rating for copper cabling, industrial designers and control engineers considering the use of fiber optics in their industrial networks will save time and be able to specify networks more efficiently by choosing fiber optic cabling that has been tested to much of the same rigorous standards.

That is why Corning Cable Systems has made the investment to independently test and verify that their Industrial Solutions indoor and outdoor cables have the increased tensile capacity, impact resistance, crush resistance and cold temperature performance that makes them truly tray-rated. Combined with their low-smoke/zero-halogen safety features, and the inherent advantages offered by fiber optics, Corning Cable Systems Industrial Solutions offer manufacturers an innovative, rugged, reliable technology that will future-proof control systems and automation needs.

WIRELESS FOR INDUSTRIAL NETWORKS

Copper cabling and fiber optics are the two media cable types most commonly used for industrial networks. There is growing interest in replacing physical connectivity with wireless communications, particularly for I/O and other machine automation requirements. However, wireless for the factory floor is still an evolving technology with several issues remaining to be resolved:

- **Protocols:**
  While the IEEE 802.11 protocol is the current basis for wireless LANs, the protocol subset addressing wireless on the factory floor is still evolving.
- **Interference:**
  The risks associated with electric noise, feedback and static that exist for copper cabling exist to an even greater degree for wireless LANs, since there may be overlapping application layers for different systems in one large location.
- **Security:**
  Wireless LANs are part of an enterprise network and represent vulnerable points of entry for hackers seeking access to corporate databases and proprietary material.

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