

# High-Performance Fiber Optic Cables Bring High-Bandwidth Communication to the Factory

The ruggedized fiber optic cables made by companies like Optical Cable Corporation, one of our BBP Top 100 this year, stand up to harsh industrial conditions.

By David Rizzo ■ *Technical Writer*

**F**orget the polo shirt, slacks and Rockports. Today's user of high-speed communication links is likely to be wearing overalls, a hard hat and boots.

Now that industrial applications increasingly call for collecting and moving large quantities of data at gigabit speeds, high-performance fiber optic cable is migrating from the cool confines of air-conditioned office buildings and data centers into the rough-and-tumble environment of steel mills, oil refineries and chemical plants, where temperatures may exceed 100 degrees and cables may be subjected to mechanical stresses and harsh chemicals.

These harsh conditions challenge the ruggedness and durability of previous-generation fiber optic cables. While typical loose-tube or "indoor" tight-buffered cables may suffice for some noncritical applications, today's plant managers are now demanding the performance advantages that the highest-quality, abuse-resistant tight-buffered fiber optic cables offer. With exceptional bend, crush, impact, and chemical resistance across a broad thermal operating range, ruggedized tight-buffered cables are speeding installation, reducing attenuation loss, and maximizing uptime.

"I was involved in one of the first wastewater treatment plants that ever used fiber optic cable," recalls Charlie Motz, a senior engineer with Control Instruments, Inc. (C2i) of Smyrna, Georgia, a nationwide system integrator of custom-engineered systems for the municipal water/wastewater market. "But we don't bother with loose-tube

stuff anymore. Instead, we now use ruggedized, tight-buffered cable because it's quicker to install, more reliable and of greater value in the long run."

## Low Cost Equals High Risk

Loose-tube fiber optic cable, which is nearly as old as glass fiber itself, is still used in some commercial and industrial enterprise applications and in many long-haul backbones because of its relatively low cost. Low-quality indoor-rated tight-buffered cables are used in similar applications, for the same reason. But in today's industrial plant, which calls for utmost durability and fail-safe operation, any initial cost savings from lower-quality cable are wiped out by the economic consequences of interrupted processes or halted manufacturing runs caused by data loss or cable failure.

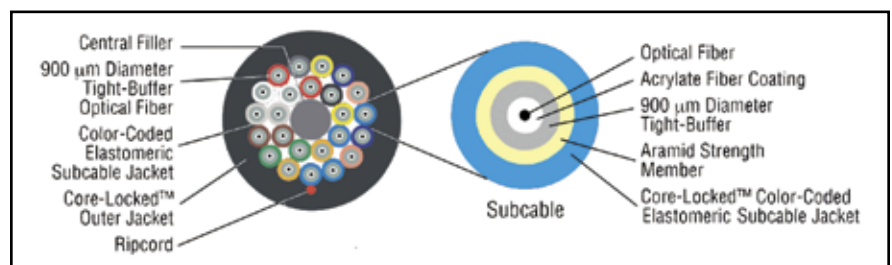
Because the cost of cabling represents a small fraction of a communications system – which includes expensive network equipment, cable connectivity hardware, installation and testing – a price premium of between 10 and 20 percent for ruggedized tight-buffered cable increases the total cost of the system by only a small percentage. On the other hand, skimping on cable quality

may end up costing many thousands of dollars per minute in system downtime, especially for critical applications.

While loose-tube designs have only one thin coating surrounding each optical fiber, ruggedized tight-buffered fibers have two. The fiber coating on loose-tube cables is only 62 microns thick, providing minimal mechanical and environment protection to the glass fiber during cable handling and stress. But on tight-buffered fibers, the secondary buffer increases the total thickness of the coating by a factor of six, to as much as 387 microns. Several of these individual buffered fibers are then tightly bundled within a sturdy cable jacket to create a unit that is highly water resistant by virtue of the tight bundling and special fiber coatings.

For exceptionally demanding applications, some cable manufacturers customize cables by jacketing and strengthening each fiber subunit before bundling them into the final cable jacketing. These "breakout cables" can exhibit low loss in the face of extreme operating temperature ranges and extraordinary mechanical stress.

Loose-tube designs, with their fragile, thinly coated fibers contained in



Cross section of the Optical Corporation ruggedized cable.

rigid hollow tubes, can't begin to compete in the harsh environments often encountered in today's factory settings. Because they are relatively stiff and inflexible, loose-tube cables can develop jacket splits and breaks from flexure and abrasion, allowing water penetration and ultimately damaging the fiber. Tight bends or kinks in the tube can actually collapse the cable and break the fibers.

Even some indoor-rated tight-buffered cables can suffer degradation or failure caused by both long-term abuse and installation assaults. Finding fiber optic cables that are capable of withstanding the mistreatment inflicted by manufacturing plants, petrochemical refineries, oil and gas platforms, mining sites, seismic testing facilities, military operations, remote video broadcasts, and transportation and security systems may require taking a magnifying glass to even tight-buffered cables.

To understand the subtle differences that allow one cable design to succeed over the life of the installation, while another fails, it's necessary to consider both installation stress and long-term environmental and mechanical stress.

## Installation Hazards

In many long-haul applications, cable is basically dropped into the ground and covered with dirt with minimum connectorization. By contrast, placing fiber in a factory requires countless bends, pulls and connections, all of which pose risks to the cable. In this environment, loose-tube designs can quickly fail. Even low-quality tight-buffered cable can break while being pulled through and around the many walls, ceilings, gantries, tanks, and material handling systems commonly found in industrial sites.

Usually, if major cable stress or damage occurs during the installation process, the contractor knows about it right away and will quickly fix or replace the damaged link. Sometimes, however, "microbends" occur during or after installation. Though these bends may be too small to notice initially, their cumulative stress can return to haunt the plant



**Ruggedized, tight-buffered cable derives much of its reliability and performance advantages from its basic design.**

***Placing fiber in a factory requires countless bends, pulls and connections. Once it's installed, harsh environments and even gravity can play havoc with it.***

with higher-loss transmissions, missing data and broken fibers. At worst, a complete shutdown in the communications link can occur.

Another installation challenge is posed by the requirement for 10 Gbps transmission, increasingly demanded by instrumentation and control engineers for certain links within the factory environment. These transmission speeds require the latest 50-micron multimode OM-3 fiber or, in some cases, single-mode fiber. However, OM-3 50-micron and singlemode fibers are much more bend-sensitive than the previous-generation 62.5 micron fibers -- hence requiring cable quality that goes well beyond minimum standards.

"We've never had a problem pulling Optical Cable Corporation's cable," says C2i's Charlie Motz. "Other manufacturers don't offer the ruggedness and pull tensions that OCC's cables can withstand."

Optical Cable Corporation ([www.occfiber.com](http://www.occfiber.com)) pioneered the design and production of tight-buffered cables for the most demanding military field applications. Its ISO 9001:2000 registered facility in Roanoke, Virginia, currently manufactures a broad range of fiber optic cables for the high-bandwidth transmission of data, video, and audio communications, including cables for the most demanding commercial and industrial environments.

## In-Service Abuse

Once cable runs are installed in a factory, their integrity remains anything but static, because harsh environments and even gravity can play havoc with them. The use of 10-Gbps communication links is increasingly revealing the fragility of all but the most sturdy of fiber optic cables. Even after installation, any kind of stress, whether mechanical loads or temperature extremes, can result not

only in microbends but also other fiber damage that in turn may lead to increased cable loss and transmission errors, or even to eventual fiber failure and breakage.

For instance, other heavy cables lying on top of the high-speed link within a cable tray can cause cumulative trauma to the glass fibers. Even in vertical runs, cable is subject to stress as gravity may cause axial migration that slowly weakens the fiber until a perfectly good installation degrades over time to the point where the link no longer functions.

When you consider that 1-Gbps lengths (limited to about 300 meters) and OM3 10-Gbps lengths (often used to extend 1-Gbps links to more than 1,000 meters) have less than 43 dB of total allowable channel insertion loss (as per the IEEE 802.3 Ethernet specification), it becomes obvious that even the slightest increase in attenuation can sabotage the communication link.

"I've been using Optical Cable Corporation cable for about 15 or 16 years, and I feel their cables are better than anything else because we have used them under conditions that were above and beyond the expected, yet we've had absolutely zero failures," says Motz. "We had one instance where a guy in a backhoe accidentally dug up some buried cable. He brought it completely out of the ground before he noticed it. We thought it was broken, but it worked just fine."

Optical Cable Corporation increases cable ruggedness with a pressure-extruded (Core-Locked) or tightly bound outer jacket that firmly binds all the fibers together so that the cable moves as a single, solid, rope-like unit. Some of these cables greatly exceed minimum industry standard requirements with flex resistance of thousands of cycles, crush resistance of 2200 N/cm, the ability to withstand 1,000 impacts, and tensile load rating exceeding a ton.

The latest-generation cables withstand environmental insults such as caustic and volatile chemicals, excessive moisture and fungus, UV exposure, and operating temperatures ranging

anywhere from -55 to +124 degrees C.

"Keep in mind that our installations are far from 'primo' because of the nature of the waterworks industry – there's submergence, abusive chemicals and sewage spills," says Motz. "Yet after the cable has been installed, we've never had a failure because of degrada-

tion or anything like that." **BBP**

### About the Author

*David Rizzo writes technical articles for Power PR, based in Torrance, California. He has published two trade books, 150 technical articles and 300 newspaper columns.*

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