Tech Article

The Seven Deadly Sins of Fiber Optics

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Does anybody in this totally digital, selfie-taking, Facebook-posting world remember the Seven Deadly Sins? Originally based on the Book of Proverbs, the Seven Deadly Sins were codified in the Middle Ages as the bad behaviors that guaranteed sinners were going to spend eternity on the wrong side of the Pearly Gates. People actually worried about the Seven Deadly Sins. The logic was stern and inflexible: Hell exists; people who sin go there; there is no escape. It was a perfect quid pro quo, entirely under the control of the individual. Your fate was in your hands.

But here's a modern headline for you: when it comes to fiber optics, there really are Seven Deadly Sins. The fate of your network really is in your hands. Not the hands of an unknown network designer, or production operator at the cable system maker or in the hands of the equipment manufacturers who built your network gear; your hands.

These aren't theoretical debates. After decades of splicing, connectorizing, testing, trouble-shooting, consulting, training and designing fiber optic systems, I personally can assure you there are real, hands-on fiber cleaning mistakes that degrade the performance of fiber networks. Let's take a look:

Sin # 1 Not Cleaning Before Splicing

Before splicing, after you have exposed the fibers it's very important to clean them before cleaving. Cleaning the fiber ahead of time removes any remaining debris from the stripping process plus any other contaminants that may exist on the fiber.

Please notice the importance of cleaning before cleaving. There is nothing cleaner than the end-face of a newly-cleaved fiber. Never clean fiber after cleaving. If you do, the fiber end-face will be contaminated. This will cause extra work for the fusion splicer in the pre-burn phase, shorten the lifespan of the units electrodes, degrade the mechanical strength of the splice in the form non-linear splices with bubbles, and cause excess signal losses.

For cleaning bare fiber, it's strongly recommend operators use a fast-evaporating, nonflammable precision cleaning fluid. While isopropyl alcohol (IPA) is commonly used, it is both hygroscopic and flammable. IPA easily contaminates because it bonds with water molecules in the air. Splicing technicians should seek out cleaning fluids that have been engineered specifically for cleaning splices. The best products are in sealed, nonrefillable containers that prevent cross-contamination and spills. Look for nonflammable cleaning fluids that evaporate quickly, leave no residues and do not contain water.

Sin #2 Use the Wrong Cutting Tools

Cable prep has long been considered an entry-level step, but it is far from that. This step determines how everything else plays out from physical connectivity to performance issues. Get it right, your network will be golden. Get it wrong… well, that's why these sins are called deadly!

The vast majority of experienced fiber techs are comfortable with hook or straight blade utility knives for cable prep. It's the tool they trained with. They know the proper pressure to apply when ringing fiber. They don't cut too deeply to avoid damaging the fiber. Using these tools requires skill, training and practice.

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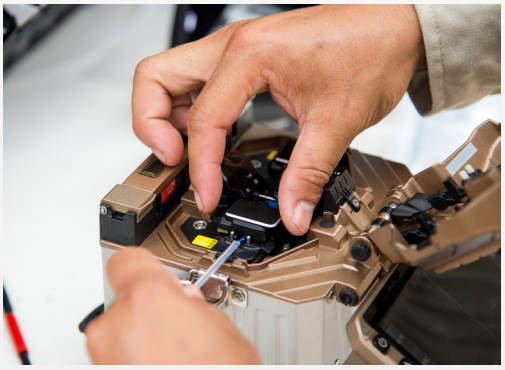
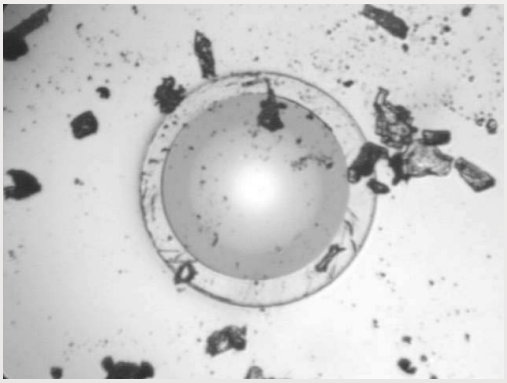


Some techs neglect to calibrate their splicer, which leads to weak or failed splices.



Particulate on an end-face causes unreliable performance.

It's the 21st century. Today there is a wide selection of safe and highly effective hand tools that do not use open blades. The latest tool designs use protected blades with improved ergonomics including adjustable tension grips and the ability to ring-and-strip the cable all in one swipe.

This next generation of tools improve operational safety while protecting the fiber inside the cable. So dump the knives and exposed blade tools and use the modern cutting tools that work for you, minimizing training and enhancing safety. These include fiber stripping tools, ring tools, hand scribes, snips and any other tools your specialty requires.

While we're on the subject of hand tools: you need to clean them as well as the fiber. An annoying issue for technicians is breaking fibers during splicing prep; it effects fiber length and splice tray management. One way to limit fiber breakage is to clean all the operator's hand tools, especially the fiber stripping tools. Wipe them down with a fast-drying solvent and a lint-free wipe to remove any oils, particulate and residues, particularly the fiber acrylate coating and tight buffer coating debris.

Sin #3 Don't Calibrate Your Fusion Splicer

Everybody knows they must keep the fusion splicer, the cleaving tool and the v-grooves clean, and to keep calcium build-up off the electrodes. But many experienced operators also have noticed there are occasional situations when, no matter how many times they try, they cannot get a good splice on a fiber. Some attribute this to imperfections in the glass; others re-clean the electrodes. If it cannot be fixed, the customer ends up with a couple of abandoned fibers. But those field techs might be looking in the wrong place.

It's important to calibrate the fusion splicer itself. Specifically, the "arch power" or "applied drive current" needs to be adjusted occasionally, to ensure the proper amount of current is being applied, so that the splices are mechanically strong and optically perfect. This is particularly true when the barometer changes dramatically or the splicing job is at a high altitude.

The calibration is very simple to perform. On most units, simply load the fibers as if to perform a splice. But instead of splicing, go to maintenance menu and select "arch calibration" or "arch burn back test." The unit will prompt the operator through any other steps and then conduct the calibration. Upon completion, it indicates it is properly calibrated or asks the operator to re-test the system. If you haven't calibrated before, multiple re-tests may be required as the unit adjusts itself for the electrical current, atmospheric density (altitude) and humidity, all of which must be configured properly for a successful splice.

Sin #4 Micro-bending the Fiber

Undetectable microscopic fiber bends ("micro-bends") are a major issue with fiber cable assemblies when securing slack loops in both premises and outside plant networks. Micro-bending the fiber causes signal degradation but the problem probably will not be detectable by visual inspection. You won't find the trouble until you grab an OTDR.

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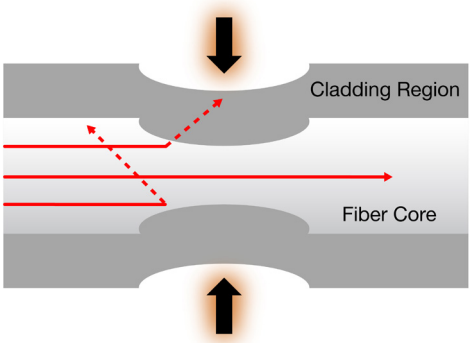

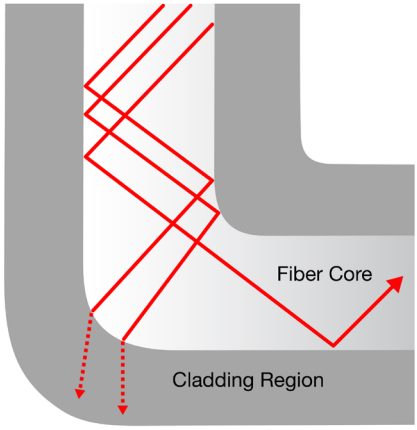

Signal exceeds the critical angle and bleeds into cladding region

What's the cause? Over-compression of the fibers. The most common cause of micro-bends is over tightening the cable ties securing the cable racking or securing the cable slack loops. Another source of micro-bending occurs when cables catch in hinges of panel doors or even stepped on.

Specifically for splice cases, a great option is to use the clear transport tubes that come with many splice cases. The loose buffer tube will form-fit into the clear transport tubes and create a tight seal. The clear transport tube will then be dressed into the splice case tray where it can be secured with a tie wrap. The tie wrap will slide freely on the outside of the hard plastic buffer tube. This will prevent anything from pinching as the fibers shift, avoiding countless other issues.

Sin #5 Exceeding the Bend Radius

All fiber cables have a minimum bend radius. Users should take care to never exceed that radius to avoid damaging the cable and the fibers inside of it. When the bend in the cable exceeds the rated minimum, the fibers within suffer a type of damage called "macrobending."

Macrobending occurs when cable slack loops are wound too tightly and placed in a pedestal, hand hole or vault that is too small for the cable diameter in underground OSP networks. Products like "snow shoes" are designed to help fiber installers avoid macrobending of their aerial slack loops. Macrobending is common occurrence when an installer "mouse ears" the slack loop and uses zip ties to secure to the aerial plant.

Macro-bending of the fibers can also occur in the splice trays. A common scenario is when small splice trays are used in combination with 60mm splice sleeves, rather than the proper 40mm splice sleeves. The larger splice sleeves will be too close to the edge of the splice tray and will not allow for a sufficient bend radius.

What effect does this have? The answer becomes obvious when you test with an OTDR. Macro-bends are often missed unless the network is tested at the 1550nm or 1625nm frequencies. Most single mode systems operate at 1310nm because this wavelength is less sensitive to bends and other issues. However, more and more applications today also are using 1550nm and 1625nm. Here is the concern: these wavelengths are more sensitive to fiber aberrations. So at the 1310nm wavelength operators may see nothing odd on the OTDR screen but at 1550nm they may see something that resembles the Grand Canyon. Avoid excessive bending and these problems fade away.

Sin #6 Hanging on to Those Dirty Wipes

It's laudable the effort employees will make to control costs and protect the environment, but re-using lint-free wipes is a false economy. In fact, it creates a network nightmare because everything becomes cross-contaminated. I have personally seen a fiber tech in a telco central office "cleaning" dozens of connectors using a disgusting, alcohol-soaked rag. I am sure if the tech had an inspection scope he would have been shocked at the damage he was inflicting on his network.

Let's suppose a company provides a large 99 inch (23x23cm) wipe for their operators. That wipe becomes contaminated when a connector wipes across it, for sure. The wipe also picks up hand oils and dust. That's bad, but it gets worse.

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A quality “high modulus” wipe is resistant to ripping, shredding and linting; it will be unlikely to deposit debris on an end-face. But most companies buy inexpensive “low modulus” cellulose wipes, held together with glues. These wipes shred easily as the sharp edges of a connector rumble across the wipe. Re-using those wipes definitely will redeposit particulate onto the end-face.

Wipes are not a significant consumable expense. Let’s concentrate on getting the connectors really clean and avoid the expense of a repair visit. Three important tips come to mind. First, don’t buy large wipes; buy the smallest possible wipes. Avoid jumbo-sized bags of wipes; select wipes in proper packaging to keep them clean until ready for use. Lastly, teach your team that any wipe, once used, must be trashed. How much is it really saving you, if you have to waste extra time troubleshooting problems?

Sin #7 You Can’t See If You Don’t Look

Every field tech and every truck should be equipped with a low-power end-face inspection scope and proper end-face cleaning supplies. Even after 25 years in the industry, it still is shocking to me to see operators trying to clean fiber end-faces by wiping them on their shirts. The same lint that is removed from the dryer cage when you wash your clothes will get on the ferrule end-face when you use your clothing to clean a connector. Every major equipment manufacturer and cable system maker recommends inspecting and clean when necessary before installation.

Operators do not need fancy gear to deliver a clean, quality network. A ferrule scope will cost a carrier less than two repair visits. There are convenient, award-winning cleaning kits available that deliver great results for less than 10¢ per connector cleaned. It makes sense to spend a few pennies to save hundreds of dollars on fiber cleaning mistakes and avoidable service calls.

Avoid the Costs of These Sins

These Seven Deadly Sins have long been a problem within the fiber industry. Like sloth and gluttony, these fiber optic sins have added significant and avoidable costs, slowed otherwise fast networks and caused significant network down time. Simple process changes and a modicum of awareness can make a huge difference in the performance of modern networks. We have the necessary tools and materials to avoid these sins, but just like in the Middle Ages — it’s all in your hands.

About the Author:
Sean Sheedy has worked 20+ years as a fiber optic installer, troubleshooter, system designer, emergency restoration technician inspector, project manager, sales manager, and consultant to the telecom industry, military and government agencies and OEMs. He holds 30 industry certifications and also is a F.O.A. & E.T.A. certified instructor. Sheedy developed the fiber optic installation and troubleshooting course at Edmonds Community College in Edmonds, WA and still serves as the course instructor. In 2005, Sean published Network Cabling Illuminated. While he still occasionally works out in the field, today he spends most of his days as a consultant and trainer. For more information, visit www.microcare.com.

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