Tech Article

"Future Proof" Your Fiber Optic Installations

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Outside plant operations present more fiber cleaning challenges compared to production line cleaning.

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Introduction

Better cleaning is the answer for modern fiber optic networks. The author suggests defining the "best cleaning practice" to "future-proof" each installation so the connectors are perfectly clean first time, every time. Better cleaning saves time and money.

In just 50 years, the capacity of fiber optic networks has increased astronomically. The "theoretical" has become "practical" with astonishing regularity. With all the advances there remains one weak link: contamination on surfaces at the time of test and transmission. In the "good old days" of megabits-per-second a contaminated end-face was not as much a concern. Today, insertion loss and reflectance impact speed and capacity as we jump from megabits-per-second to terabits and beyond. Here's the absolute truth: modern, faster networks are more vulnerable to contamination than older, slower systems. This is compounded by a lack of awareness that connector surfaces are not merely 'flatland" two-dimensional objects but use all three dimensions, and contamination is found on any of those surfaces.

The Benefits of Better Cleaning

Better cleaning is the answer but the cleaning product selection is often wrongly based on convenience or cost. A better decision is to find the "best practice" that will "future-proof" each installation so precision cleaning happens the first time, all the time. Cleaning should be simple, consistent and remove the widest range of contamination. In many instances, existing products must be upgraded to "get it clean the first time" quality and procedures.

Better cleaning saves money. While training in California not too many years ago, I observed hundreds of "defective" patch cords discarded into a 55-gallon disposal drum. I asked permission to take some back to my lab. With proper cleaning only one assembly failed to meet specs. Imagine all the profits lost over improper cleaning!

Let's take a look at the best way to clean. This paper does not endorse any specific products but rather offers insights on "best practice, do-it-right-the-first-time" processes.

Cleaning Standards & Processes

The base-line standard for cleaning a fiber optic connection is IEC 61300-3-35. Typically, an International Electrotechnical Commission (IEC) Standard is developed over five years and results in a standard that is in place for about ten years. In rapidly evolving industries such as fiber optics these standards become "minimums" and not the "best practices" to future proof your network.

The fiber optics industry is split into two worlds, each using the same technology but in very different environments. One world is the Production Line and the other is Outside Plant. A production line is a tightly-controlled environment. As such, IEC 61300-3-35 is an appropriate standard. Outside plant is impossible to characterize: the work environment varies widely. Existing standards don't "transfer" well from Production Line to Outside Plant.

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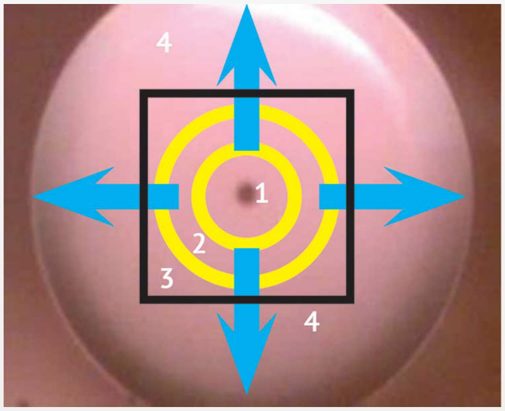

Figure 1: A contaminated end-face.

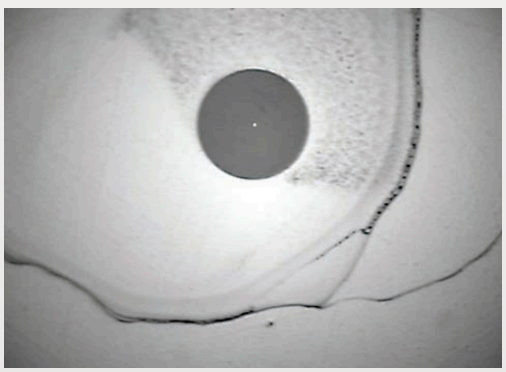

Figure 2: IPA residue on an end-face degrades network performance.

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When Cleaning Fiber Optic Connections, There are Three Factors:

1. What is the connector? You will need different tools for a 2.5 mm jumper, an MT-type port or an expanded beam system.

2. What is the contamination? Contamination varies widely from a dusty lot to a flooded zone and all points in between.

3. What tools and processes can be deployed to insure the connector is ready for high-capacity service? Train to "worst case" as this leads to "best practice".

From a series of recent surveys, I calculate that less than 60% of all fiber connections are inspected. If the technician cannot see the surface it's impossible to know if the surface is actually clean. To "future-proof" your network every cleaning must be followed by inspection. "Know what you are cleaning and know if the surface is clean." This is an absolute requirement.

What to Look For

Figure 1: The concentric yellow rings represent a horizontal end-face as defined in all current standards. Existing standards term areas inside the box as Zones 1, 2 and 3. The outer-most yellow ring inside the back box is the limit of most video inspection scopes and is approximately 250-300μ from the "core."

What about the rest of the connection? The blue arrows 'outside the box' represent the physical area of the end-face not seen. I classify this area Zone 4. Here is an image of the end-face and alignment sleeve: the black spot is contamination.

There also is a Zone 5. Zones 1 through 4 are two-dimensional "flatland" surfaces. Zone 5 is the vertical ferrule and areas not seen by inspection. Contamination can hide anywhere and, if it migrates, it can contribute to signal loss. A proper connector cleaning process should consider all aspects of the connector, including the vertical ferrule, the alignment sleeve and other "inter-surfaces."

There are myriad types of contamination. Some are dry, others are fluids and some may be "combinations" or unidentifiable. Existing standards speak primarily of "dust" but there are hand oils and any number of other residues. Fluidic contamination flows and dry debris tends to stay in place. Depending on the type, all three contamination types may, or may not, be easy to remove.

On a side-note, self-cleaning connectors would seem to be a good idea. These and other concepts likely will evolve. Be aware and be prepared: "future proof" means to "anticipate and change." It's worth re-thinking existing standards as "minimum requirements" that may not reflect a rapidly evolving technology as fiber optics.

Future-Proof Your Network

Some people are reluctant to improve their procedures. A few years ago, I lead a discussion among 75 technicians sharing ideas on "the best way to clean." One fellow challenged me, claiming "Ed, I can clean it on my shirt." I accepted his challenge and put his end-face on the scope — sure enough, it was not clean. From the back of the room, "You did it wrong. You gotta use under the collar of your shirt!"

There is reality and there is mythology! Some existing practices are passed on because training is often a 'one time' event. This was fine for hitting a nail with a hammer…until the nail gun was invented! Be aware of deficiencies and be prepared to change from ineffective cleaning techniques to successful ones.

There Actually are Three Fiber Optic Cleaning Techniques:

1. The first technique is cleaning without inspection. I call this "blind cleaning." If you cannot inspect every end-face, then a high-quality process using advanced cleaning products must be selected to have a chance to get "best practice" results. Using quality cleaning products becomes a "safety net" when you can't inspect.

2. Existing standards call out a cleaning process with begins with a "dry technique." This may be satisfactory if the contamination is fluidic (as absorbing a spill) and inspection is used. It can be inadequate for removing dry particulate as "dry cleaning" may create a static field that can attract additional debris. Inspection is critical: each time the connection is opened.

3. If "dry cleaning" does not work, then standards suggest the "wet-dry" technique. Be aware, too much cleaner can "flood" the 3D nature of all connections. Be sure to use a cleaning fluid designed for fiber cleaning such as Sticklers™ cleaners and a few other vendor products. This is true precision cleaning.

Cleaning Tools to Avoid

There are several cleaning products you must avoid: (a) cellulose (wood pulp paper) wipes; (b) ordinary isopropyl alcohol; it simply is not an effective cleaner and (c) inexpensive, refillable "pump containers" or "squeeze bottles" because these bring outside moisture into the container and reduce the cleaning effectiveness of the fluid.

The Best Cleaning Process for All Connectors:

- Always use a pure, fiber optic-grade cleaning fluid. Less fluid is better; about 0.1 ml is sufficient. That's about a spot about 3/4 inch (1.5 cm) in diameter.

- Use fiber optic applications-specific-grade wipes, cleaning sticks (swabs). Accept training from the manufacturer.

- Always dampen the stick/swab or wipe. Push to clean tools also may benefit by dampening if you have the time. This may also be accomplished with a lightly moistened push-to-clean tool. Using a fluid to clean dissipates a static field that could accumulate on the end-face and not attract additional contamination.

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Tools that have a long "throw" pull enough tape or ribbon over the end-face and aren't contaminated by a soiled alignment sleeve.

Cleaning fluid in metered doses limits waste and worker exposure.

Things Not to Do

- Do not use a "figure-8" movement that can retrace debris over the cleaning path.
- Do not push too hard because that can grind debris into the end-face.
- Never re-use cleaning wipes or swabs.
- Never clean by pressing the end-face onto an inflexible surface or by wrapping a wipe over a dirty finger.
- Don't expect aerosol dusters to clean: high-velocity versions will "dry" but not "clean".

Tools to Use

The savvy engineer will request "Product Spec Sheets" that explain a products' features and benefits in detail before you commit to purchasing them.

Examples Include:

- Cleaning Sticks (swab tools): Some swabs, such as the Sticklers™ CleanStixx™, will clean the Zone 5 alignment sleeve. Ask the manufacturer for their "storm damage" procedure. This is likely different from the "precision cleaning" performed "day-to-day."
- Push-to-Clean Tools: These can be very convenient and very effective. These tools are often the only economically-viable option for cleaning large numbers of ports, such as in a data center install. However, it is easy to contaminate the cleaning ribbon when inserting the tool into the port. Look for tools that have a long "throw" that pulls enough tape or ribbon over the end-face that first has not been contaminated by a soiled alignment sleeve. Some "threads" do not clean as much of the surface as "ribbons." These are effective, application-specific tools. Use them properly.
- Wipes: The most efficient wipes are hydroentangled polyester-cellulose blends. If you use "microfiber" make sure it's cleanroom-grade and not clothing-grade! Lastly, 100% polyester is not absorbent and can induce static field contamination.
- Fiber Optic Cleaning Fluids: These must be effective over a wide range of contaminants, safe for the worker and environment, and cost-efficient. Nonflammable liquids are easier to transport. Nonrefillable packaging is cleaner and does not cross-contaminate. IPA (even 99% alcohol) is noted as an inappropriate cleaner by most existing standards. Better technologies are available such as nonflammable, fast-drying precision cleaning fluids. These have excellent cleaning, handling and storage characteristics. Some forms of "precision hydrocarbons" are effective choices but they all will be flammable.

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Conclusions

I would suggest a "1st Time Cleaning Standard" should be the goal of all network designers and installers. Other suggestions to "future-proof" your network:

Fiber cleaning is not a "product choice" — it is an application-specific "process choice" based on "worst case" contamination that leads to "best practice."

- "Best Practice" would be for network designers to include an "applications specific" cleaning procedure with each design. Reach out to manufacturers for support.
- Cleaning standards for production lines do not transfer easily to field operations.
- Video inspection is essential for every connector, every time.
- Eliminating improper cleaning processes is the key to minimizing network failures.
- Training is crucial. Eliminate the myths-of-cleaning by retraining now.
- Future-proof your network with a cleaning procedure based on the concept that the "worst case" leads to "best practice."

About the Author:

Ed Forrest has a long career in the fiber optic industry, including patents, products in production and patents pending. He is an expert on the 3-D nature of connectors, contamination, cleaning and the implications for network design and performance.