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Written by Johnny Hill the chief operating officer of Clearfield, Inc.

Fibre Management and Its Role in Cloud Computing

Sitting at home the other day with some unusual downtime between work and family, I actually had time to review and organize my most prized digital assets: pictures, videos, and music. My collection represents images chronicling more than 25 years of marriage, including many scanned wedding photos (as there were no digital cameras or smartphones then), videos of the children when they were young, and a library of all the music I have grown up with and purchased along the way—a grand total of about 80GB worth!

Memories are life's most prized possession. And because of that I go to great lengths to ensure they are protected against what would be a disaster if I lost them all. Besides my iMac, I store to a router/backup on a regular schedule. I also back up monthly to a portable hard drive that should be kept off site but for now is in the house. Music is further backed up (with some tricks) on what seems like a dozen iPods among the family. I also save to storage in the cloud using a subscribed service. The cloud is my absolute failsafe should all other measures fail. I have entrusted all my data and assets to reside somewhere out there in the cloud and in the data centers of the world. And they are doing everything they can to protect them, right?

I am not alone in my efforts to protect. An entire industry has been changed to serve the data storage and redundant efforts of businesses through these data centers and colocation companies and also to serve the data-protection needs of the everyday consumer—most of which have multiple digital devices capable of creating gigabits and terabits of data through smartphones, MP3 players, notebooks, laptops, and computers.

Cloud computing, data storage, colocation: it's not a new concept, but its importance and need is rocketing to the top of business strategies and priorities. The recent data-center acquisitions from telecommunication companies is further proof that data storage is a major initiative.

The use of data centers has changed from a place to get our lost content to a place where we interact with our content on a daily, dynamic basis. The strain this has put on data centers extends beyond the capacity and redundancy of servers and switches to the physical media, the highway, used to transfer it all around. Copper was replaced by multimode fibre. Multimode was replaced by 50-micron laser-optimized fibre. And multimode is quickly becoming replaced by the limitless bandwidth potential of single-mode fibre. We have seen the evolution of connectors from FDDI and biconic move to FC/ST and to SC, and it is now trending toward small form factor (SFF) connectors such as LC and multifibre connectors such as the MTP. Like FTTH, where a dedicated fibre is run to every home whether it's a single-family unit or otherwise to deliver unbelievably bandwidth-intensive content, the same is true in the other direction across the same platform into the cloud and to the data centers.

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As more and more data is being pushed to these providers for dynamic storage and retrieval, expansion of these centers is accelerating, and real estate is quickly consumed using the traditional fibre-management products available today. Fibre frames are being asked to provide more density, and they are doing so, but is the requirement for more density coming at the cost of a reliable network? Are shortcuts being taken, using solutions not designed for the kind of density being demanded? The importance of fibre management and connectivity should not be overlooked when building a data center that services the needs of consumers sending and retrieving their most prized assets.

The Importance of Fibre Protection

The whole point of every component in a fibre management system—from the 125-micron cladding to the cable jacketing, splitter packaging for outside plant and the route paths inside them—is to protect and reduce the risk of fibre damage.

A product that does not accomplish this in an easy and intuitive way is over-thought and costly. We approach fibre management with three simple goals in mind. Our first and most important objective is to deliver solutions that minimize fibre risk in the cable plant. Second, our responsibility is to eliminate deployment *and* maintenance headaches. And last, we must reduce the cost of deployment through reduced capital equipment costs and also operational costs.

In early 2000, a joint study between two RBOCs reported that in the two weeks immediately following a tech-service labor strike, trouble calls to the technical assistance centers reached or came close to all-time lows. The reason? Nobody was out messing around with the cable plant. Naturally, as normal maintenance tasks went unperformed, the network began to suffer. The important factor to note is that when human interaction with revenue-generating live circuits occurs, the risk of network "trouble" increases.

Any optical circuit that is being touched or that is moving is at risk. Thus, it would make sense to use solutions that minimize these "touches." Central to sound fibre-management design are products that have no moving parts. By eliminating unnecessary interaction with the fibre, the human factor is minimized.

It's Not Just the Glass

The emergence of bend-insensitive glass over the past decade has provided obvious advantages. As a result, the three-inch bend diameter that was driven as a standard inside of GR-449 for central-office mainframes, and that was core to every fibre-management design for the last 25 years, seems not to be receiving the scrutiny it once was. Fibre cabling that uses the G-657.A standard creates perceptions that users mistakenly seem to associate with a "failsafe" condition. But bend-insensitive glass (BIF) does not solve every problem. At trade shows and field installs alike, it seems that whenever BIF is used, an increasing amount of fibre is crammed into ever smaller places—seemingly without regard for the need for bend-radius protection. Manufacturers of fibre-management products are mistakenly designing route schemes where a jacketed fibre circuit travels over a 90-degree edge, thinking their bend-insensitive fibre can handle it. Initially, a few jumpers can handle this. Over time, as the maximum capacity of the fibre-management product is reached, weight and friction affect the long-term reliability. Try placing a bend-insensitive patch cord on a light meter and pinch the cordage to a 90-degree turn and you'll know what I mean.

If the fibre is not bend-radius protected and is subjected to a hard 90-degree turn, a piece of sheet metal or a sagging jumper pushed into a corner, it can suffer from a condition of intermittent light to no light. Many can attest to the frustration experienced when a 10-dollar patch cord brings down a million-dollar network.

Terminated Connector Performance: It's More Than Just IL and RL

The manufacturers of fibre-optic patch cords are many and, as a result, enable competitive pricing to the end user of these products. As the product has been more commoditized, it is wrongly assumed that all patch cords will perform the same as long as a few given performance metrics are met. Most associate good insertion loss (IL) and return loss (RL) as the only recipe for a good patch cord. As a result, the barrier to entry is low. There are many "garage shop" environments that can produce a fibre patch cord to meet these metrics, but are they really producing a good patch cord that will perform reliably over time? The answer is unknown, as they have not made the financial commitment in test equipment that validates whether their process is capable and repeatable. Because their metrics are limited, they can claim first-pass yields (FPYs) that are on par with a world-class manufacturing environment and yet offer a price and lead time that appears very attractive to the user.

It is important to understand what makes a good patch cord by taking the time to research and ask some critical questions of vendor candidates. Your inquiry and choice of a vendor should at the very least address three areas: the connector hardware, termination process and final inspection methods. Failure to do so puts your revenue-generating circuits at risk. Patch-cord termination quality and performance issues can cause you major headaches, as they are often difficult to troubleshoot. A few pennies saved is not very comforting when those few pennies are the reason that your network or critical customer is screaming "network down!" at the worst possible time—which is anytime it is occurring.

Where do I start?

To begin with, a GR-certified connector should be used. This is a connector that has been tested at Telcordia or a third party and meets or exceeds the standard for this network component. You should ask the size of the ferrule being used. Smaller sizes improve the chance of concentricity (measure of how well the fibre core is centered in the ferrule). Some use a large 127-micron capillary, while a 125.5-micron size improves this metric data, as the core/cladding of a terminated fibre measures 125 microns.

Ask if epoxy is being de-gassed, especially if you will use your patch cord in uncontrolled environments like the OSP. What kind of prepping equipment do they use? The more automated equipment used, the lesser the chance of critical failures in the long term. A manufacturing process can cheat the system by using manual and cheaper prepping tools. Manual prepping tools can cause nicks in fibre that will become evident over time. What kind of cleaving does the vendor perform? Is it manual, which requires a high level of skill achieved by years of experience? Automated processes like a laser cleaver greatly improve first-pass yield data and deliver a more repeatable performance process.

Test and Measurement

Your minimum requirements should include data that meets insertion loss and return loss (reflectance) requirements. Insertion loss should meet the 326-Core minimum of .4dB, with reflectance meeting 55dB for UPC connectors and 65db for APC. Asking the typical performance measures of a manufacturer's process can save you on link-loss budgets over a long fibre run through an FTTH network.

Apex offset, the measurement of how well the center core of the fibre is centered in relationship to the spherical apex of the polished tip, minimizes lateral offset between two fibres and maintains a better physical contact.

Fibre undercut or protrusion affects the physical contact zone. Too much undercut minimizes the chance of a good physical contact, and too much causes excessive fibre deformation when mating, resulting in signal degradation.

Radius of curvature measures the end-face radius and should be between 5mm and 12mm to ensure an optimal mating function. Too much or too little radius can cause light scatter or inadequate physical contact for optimal signal transfer.

Apex offset, fibre undercut/protrusion and radius of curvature are the main ingredients that work in concert to deliver good IL and RL performance. Processes that drift out of this geometry range can still yield acceptable IL/RL, but sensitive traffic will be affected (such as video), and the long-term performance of the connector will be compromised.

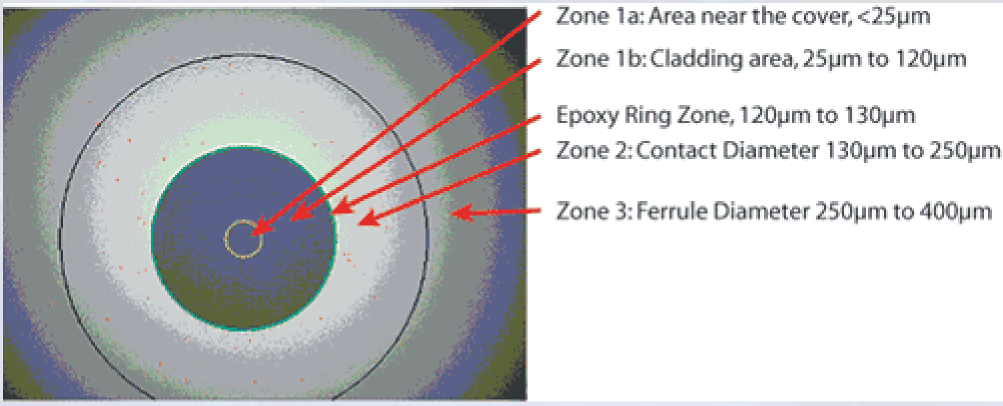
Your vendor should be able to provide these geometry test reports with on-hand interferometer testing. Although you may not require this data for every connector, you should require that random testing is performed to ensure the process is capable and not drifting out of spec. "Garage shops" will not be able to deliver this test data on demand.

Your test reports should report each connector independently, rather than a total report that summarizes both ends.

End-Face Quality & Cleanliness

No industry standard exists for end-face quality and cleanliness, but end-face defects and contamination have a direct impact on the performance of the connector.

Several organizations (most notably, NEMI) have studied the impact of end-face defects and cleanliness. The influence of the contamination/scratches becomes more evident if they are located in the core/cladding areas. Particle contamination can cause a significant increase in IL (up to 10 times) and decrease in RL (up to three times). Scratches applied to fibre contact zones 1a and 1b, which is an area from the core out to the cladding (125 microns), decreased RL by up to 25%, whereas scratches located in the cladding layer showed little effect on IL and RL. Multiple heavy scratches passing through the core caused severe performance degradation in IL and RL and can be catastrophic.



Core/cladding zones.

Connectors with particle contamination will pass on contamination to mated connectors. Contaminants can prevent direct physical contact, creating an air gap. Multiply this by the number of re-mates over time, and the problem spreads. Pits and scratches in the critical contact zone 1a will collect particulates over time, and the same contamination spread occurs. Long-term reliability in dynamic circuits is severely reduced compared with those that are static. Scratches and polishing marks outside of critical contact area are acceptable and do not have any impact of signal performance.

Quality fibre-assembly manufacturers and OEMs will have their own inspection criteria. These specifications differ from company to company, however, and these differences can cause materials to be “nonconforming” at user/customer sites.

What Will Your Inspection Criteria Be?

Your vendor should visualize at a minimum 400X magnification. Although some manufacturers require that there be no visual damage at this magnification in the defect zone (roughly an area 8x the diameter of the core), others require that the entire contact zone be void of defects. Others might allow one pit and one scratch *x* microns long or wide. There should never be any scratches or pits through the core.

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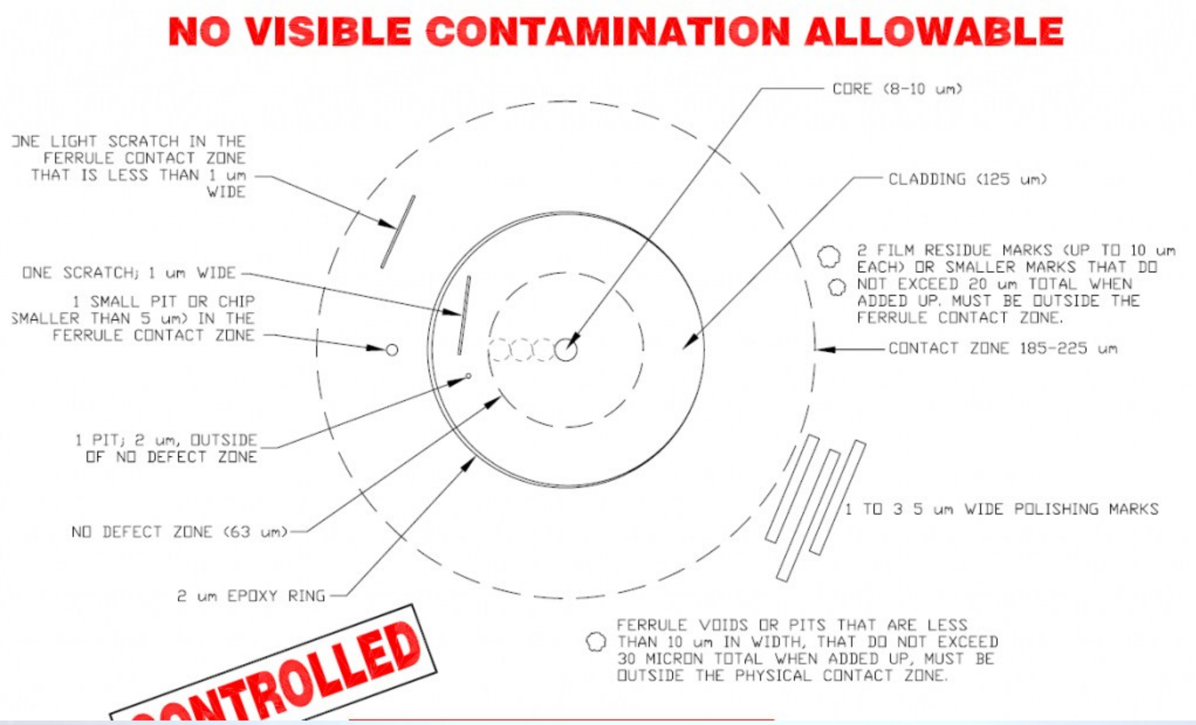
Other manufacturers will allow some defects in the contact zone. And some, the ones you should avoid, do not have a standard in this area. An important point: zero defects in this area are achievable, and you should ask for it.

An end-face defect and cleanliness spec should look something like this.



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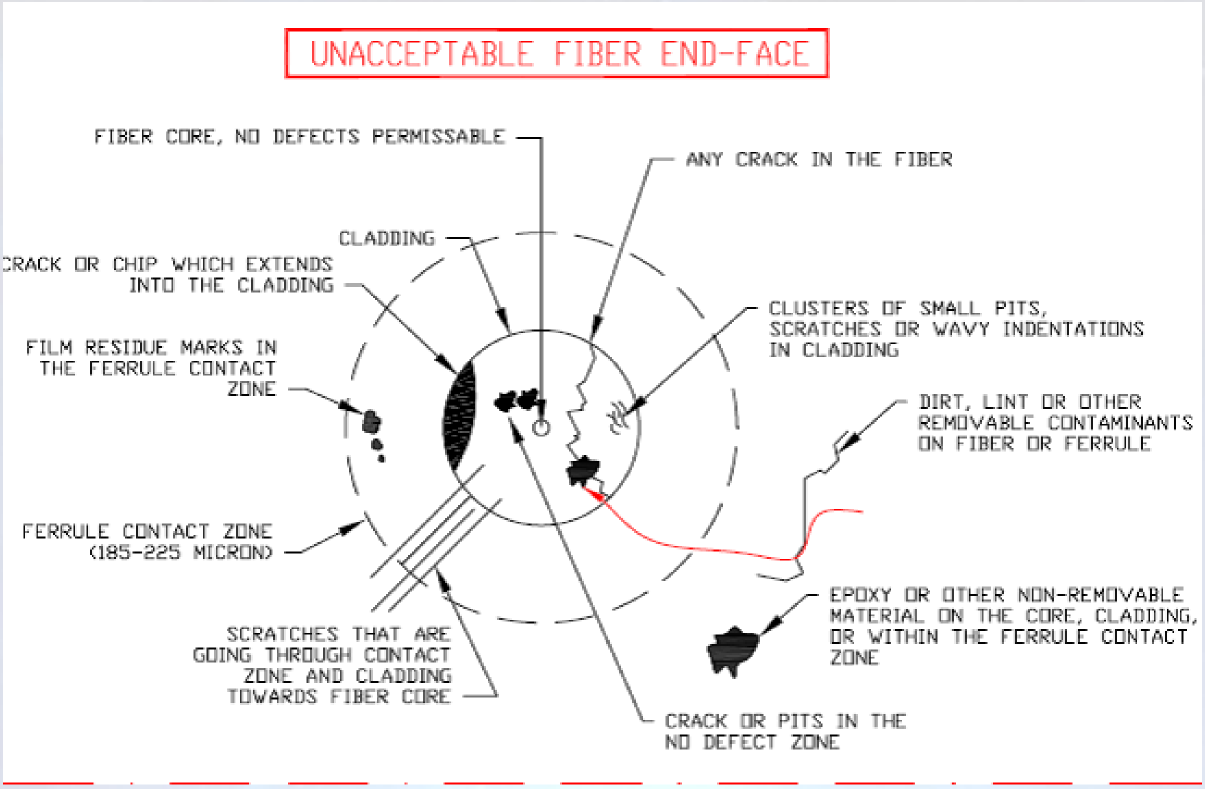
QAS INTERNATIONAL ISO 9001:2008 REGISTERED FIRM

NSI NACOSS GOLD

UKAS QUALITY MANAGEMENT 001

An example of an unacceptable end-face.



Taking a little time up front to review your vendors' connector choice, termination processes, test and performance methods, and stated and published end-face criteria will weed out the garage shops and leave the world-class manufacturers standing. This is important to your investment in the reliability of your entire network.

Back to My Memories

My memories are priceless. I pay a small fee to ensure that my data is backed up in "the cloud." Enterprise networks across the continents put a more defined price tag on their data assets, and as such, central-office managers and planners must be diligent in their pursuit of building a network that is up to the task. Ensuring that every point of connectivity offers premium performance and reliability requires paying strict attention to every element of the fibre-termination process, and it requires true discipline to the requirement of protecting the fibre port at every feeder and distribution throughout the network. With millions of dollars invested in the real estate and electronics of a data center, skimping on fibre connectivity, protection and management would be a penny-wise, pound-foolish mistake.

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About the Author

Johnny Hill is the chief operating officer of Clearfield, Inc. Formerly the vice president of engineering and product management, Hill is considered a longstanding leader and a founding member of the company. He has approximately 15 years of strategic and hands-on experience in the telecommunications networking industry. He started his career at Americable Inc. in 1996. He was Americable's national sales manager when the company was acquired by Clearfield's precursor, APA Cables & Networks in 2003. Hill was promoted to Clearfield's vice president of product management and development in 2006, and vice president of engineering and product management the following year. During his career, Hill has amassed a national reputation in the telecommunications industry on such issues as fibre management, harsh environments, network design and transport, fibre and copper assemblies, network security, premise network equipment, structured wiring, and others.

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