CONSIDERING FIBER OPTIC CONNECTIONS IN THREE DIMENSIONS

Understanding Primary and Secondary Connector Contamination

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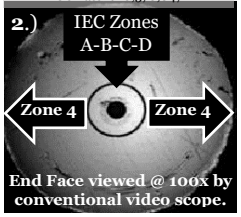
Abstract: To study The Sciences of Cleaning students are taught three tenets: 1.) What is the debris, 2.) Where is it located, and 3.) What is the best means to remove it. [a]

Additional subsets include knowledge of material substrates that might be damaged by the cleaning process. Essential to successful soil removal is understanding of environmental, health and safety standards that impact the end result…as well as the efficacy of the cleaning process. [c]

For fiber optics, before the first standards were established, an inspection may have been performed using a jeweler's loupe, then a direct view microscope that, improperly used, could cause eye damage. [b]

THE CORE OF THE MATTER

It's thought that early fiber optic inspection devices were "limited' by 100x magnification. The inset (1) is a digital photograph of a complete 2.5mm end face. This is a three-dimensional view of what is often regarded in two-dimensional 'diameter'. Image 2 is a 100x magnification. The circled area (1,2) is the diameter as currently standardized. It is the only surface area required to be cleaned. Noted in both images is debris outside this surface area defined by IEC 61300-3-35. Image-1/2 suggests a recharacterization to five zones.



Extensive research and practical experiences prove unseen debris may cross-contaminate. Because it is not seen and, not considered … it's not removed. Understanding debris in Zone-4 (the total horizontal) and Zone-5 vertical surfaces is essential to future proof deployments. These are new, proposed characteristics.

Over the last twenty years, inspection has evolved to higher levels between 200x and 400x. *The higher the magnification, the less of the actual surface is seen*.

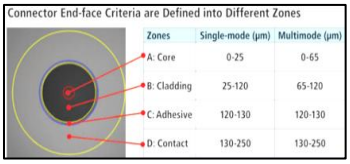
Image-3 is the same connector as viewed at 400x. Existing standards require cleaning the surface as noted within the IEC area (2). This is an important first-step; it is also a minimum requirement. [c]

These images, from three different inspection devices, portray the 'core' or transmission fiber.

No matter single mode or multimode, one fiber or multiples, direct contact or expanded beam, the prudent trainer, marketer, researcher and craftsperson accepts the three-dimensional nature of connector surfaces and plans cleaning methods and procedures accordingly. Multiple cleanings *of the same surface* will not resolve insertion loss, reflectance or misalignments. Always consider other sectors of the connector including alignment sleeves and adapters. *These may be points of cross-contamination.*

PRIMARY AND SECONDARY CONTAMINATION

Likely you have seen this graphic: the surface area as defined by IEC 61300-3-35.

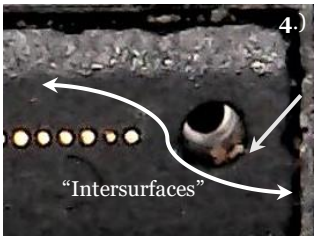


This is the area of "PRIMARY CONTAMINATION". Debris removal from this 'Primary Surface' area is critical. Each fiber is characterized in this way.

Although defined and trained by IEC 61300-3-35 and multiple other standards [d] I consider this as a *minimum requirement* to best practice.

Equally-critical are "Secondary Surfaces". (4) These are surfaces outside the field of view of IEC "Zone-D" in an approximately 250-400 micron diameter around the 'core' fiber(s) or IEC "Zone-A".

Awareness of the potential for cross-contamination is not trained since most fiber optic inspection cannot see these surfaces.

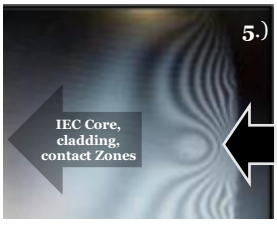


Secondary Surfaces include: [a.] the total horizontal end face, [b.] vertical surfaces, [c.] alignment sleeves/ports, and [d.] spaces between transmission fibers termed 'intersurfaces'.[e] All fiber connectors have these characteristics and advanced characterizations.

WHY DOES IT MATTER?

In 2003, my understanding of 'SECONDARY CONTAMINATION' arose from a product complaint! The end user expressed how, when using an IPA pad to clean, the surface would 'pass' inspection only to fail in subsequent days. Image 5 is a screen shot of a video [f] and demonstrations performed many thousands of times confirm this incidence of cross-contamination.

The phenomenon pointed by the arrow is 'fluidic contamination' *in motion* from outside the field of view of 200-400x inspection and auto-detect. This excess solvent is leaching from the "Zone-5" vertical ferrule, can cross contaminate to the back plain, alignment sleeve, as well as other horizontal and vertical sectors. This surface might 'pass'…only to have excess solvent flow on to the transmission surfaces. A finger print or dust may cross-contaminate jumper-side to back plane.



Both "Primary" and "Secondary" contamination may influence any fiber optic deployment.

Debris may transfer or be present on unseen surfaces.

A higher standard can be considered as best practice beyond existing minimum requirements.

a.) N.R. Cooper, William Spontak: Union Carbide Corporation®, Technical Services-1968, A. Friedman, Founder, Chemtronics©-1990. **b.)** FOA Reference Guide-2018. **c.)** "How We Do and Should Not, Should and May Not, Clean and Inspect a Fiber Optic Connection" Edward J. Forrest-2016. Amazon.com **d.)** IEC 61300-3-35, TIA 455-240, SAE AS-3, AIR 6031 IEEE Guide for Installation Methods for Fiber Optic Cables in Electric Power Generating Stations and in Industrial Facilities," in IEEE Std 1428-2004 , vol., no., pp.1-31, 18 July 2005, **(e)** "Breaking Through Myth to Reality. A future proof view of fiber optic inspection and cleaning". Edward J. Forrest, Jr. 2018 **(f)** YouTube® edforrest channel