

# A Need for Processes that Future Proof the Fiber Optic Installation

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## ABSTRACT

The tenets of IEC 61300-3-35 have influenced and contributed to numerous standards. These include: a.) the importance of cleaning the fiber optic connection, b.) the concept of diameter of debris or contamination, and, c.) the area of the end face to be cleaned, d.) methods of cleaning. As capacity and bandwidth expand, deployments updated, and new technicians trained, a clear understanding of several other tenets of precision cleaning the connection may also be considered.

There are many types of debris and contamination. Some are dry [Figure-1](#) and others are fluidic [Figure-2](#). Debris on an end face may also be present in combination [Figure-3](#). The cleaning procedure should strive to be a first time event. A best practice procedure can be identified that does not require multiple techniques and numerous attempts.

Dry, fluidic, or combinations of contaminants also have height [Figure-4](#).<sup>(12)</sup> Commonly used cleaning techniques can create fluidic contamination outside the field of view of most video inspection and software analysis [Figure-5](#). Another technique can create a static field that attracts additional debris [Figure-1](#).<sup>(8)</sup>

There are well established tenets, present in everyday life, that point the direction to properly cleaning the fiber optic connection. Dry wipers, use of solvents and surfactants, and identification of debris or contamination are every-day choices. These are relevant to precision clean a fiber optic connection.

Ineffective cleaning fiber optic cleaning procedures may result in debris being mis-characterized as an artifact. Currently, IEC 61300-3-35 is relative to both production line applications (OEM) and field service (OSP) applications. Various standards are based on IEC. In this work the term OEM refers to Original Equipment Manufacturer or a production line environment. The term OSP refers to Outside Plant/Field Service, or the installation and the post production line maintenance environment.

This paper is an effort to define and update inspection and cleaning procedures to facilitate existing operations and anticipate future needs.

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## INTRODUCTION

Just a few years ago there was concern that the amount of "dark fiber" would never be fully utilized. A 40 megabyte transmission was exceptional and debate was whether copper or wireless or fiber optics would emerge as the ultimate format.

As we are in 2013 looking forward, speeds capacities are measured in gigabytes and terabytes as systems and networks are combinations of copper, wireless and fiber optics. There are consumer, business, military, DOD, trans-oceanic and myriad systems of new equipment to be deployed in the

coming years. Equipment may interface with heritage installations.

There are various standards for virtually all facets of the Industry. Considered the "mother standard", tenets of IEC 61300-3-35 have influenced numerous standards.

As capacity and bandwidth expand, deployments updated, and new technicians trained, a clear understanding of several other tenets of precision cleaning the connection may also be considered. IEC 61300-3-35 has influenced TIA 455-240, Telcordia GR-2923-CORE, and SAE AR-6031. Both the SAE and Telcordia standards suggest expanding debris and contamination beyond OEM levels.

Oddly enough, an OEM standard in plant may not be relative as the equipment is installed in OSP/Field Service. Nonetheless, virtually all standards are outdated by the time they are written and implemented. This paper is a suggestion with practical recommendations to look to exceed these standards...always with deference to those who created them. Certain “cross-over” techniques can be detrimental to precision cleaning a fiber optic connection. Debris and contamination outside common video inspection field of view (FOV) may influence results.

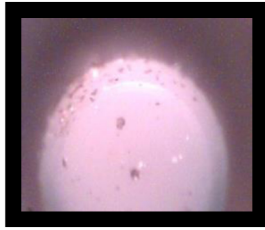


**Figure-1. Dry Debris**

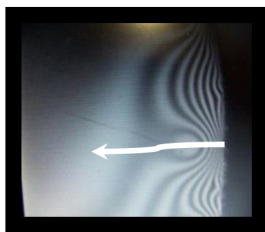


**Figure-2. Fluidic Contamination**

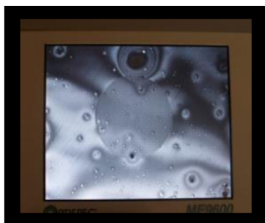


**Figure-3. Combination Debris**

## END FACE GEOMETRY: HOW IT INFLUENCES PRECISION CLEANING

For the purpose of this document, debris is defined as a dry contaminate and contamination is defined as fluidic debris. Current standards derived from IEC 61300-3-35, characterize debris and contamination as a two dimensional measurement of microns in relation or juxtaposition to the core.

However, dry, fluidic and debris-in-combinations also has height. Video inspection easily analyzes diameter of debris or contamination in relation to the core: Zone-1. Measurement of the height of debris and contamination requires an

interferometer. The interferometer reading, [Figure-4](#), shows debris of approximately equal diameter and height. Subsequent tests and readings verify these images.

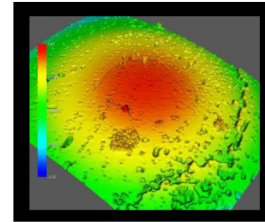


**Figure-4. Height can equal diameter**

Existing standards for end face inspection limit the field of view to three zones on the horizontal ferrule. Implied is the end face, like debris, is two-dimensional. Of course, the end face ferrule has three dimensions with a perspective beyond “Zone-3”, usually at ~125-150 micron radius of the core that extends to a vertical Zone-5 ([Figure-5](#))

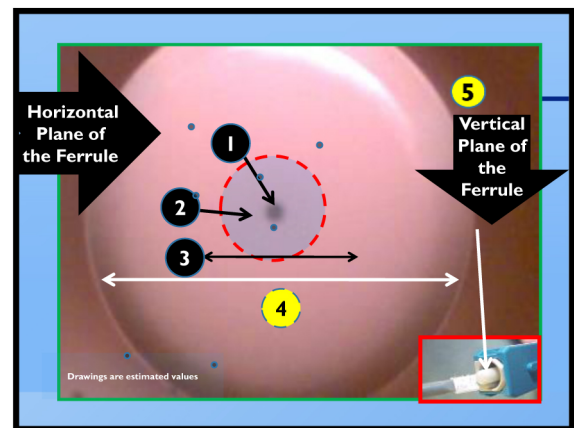


**Figure-5. A complete view of the end face**

Certain types of debris outside the field of view (Zone-3) can migrate into the core. This type of migration would most likely be fluidic contamination. Fluidic contamination can be excess cleaning solvent, an oily type contaminate, or even condensation contamination wherein a connection is moved from one ambient to another. It could also be a combination of “dry” and “fluidic” types.

There are often-used cleaning techniques that wipe-or spray-apply excess cleaner in the initial phase of cleaning. Excessive cleaning solvent can be harbored in Zone-5 and migrate in the post cleaning, post-inspection process.<sup>(13)</sup>

While video inspection at 100-200x creates a wider field of view enabling inspection outside Zone-3, video inspection instruments may not be capable of accurate image resolution to identify clearly debris or contamination.<sup>(13)</sup>

The area outside Zone-3 may be further characterized as Zone-4 which leads to the abutment of the horizontal ferrule to the vertical ferrule which may be characterized as Zone-5.

While it may be impractical to change a standard such as IEC 63100-3-35 in the short term, it is practical to establish awareness and create a best practice standard that exceeds this baseline. It is also desirable to create a new IEC Standard for field service.

Since the ferrule assembly and debris are three-dimensional, there is significance for all precision cleaning applications. A jumper-side ferrule inserted through an alignment sleeve can both transfer debris from one end face to the other. Debris on the adapter can cross contaminate connection components or create a stand-off.

As capacity and speed are doubtless to increase, implementation of effective cleaning techniques that do not cause recontamination and minimize cleaning effort are base lines to future connectivity.

## ARE THERE DIFFERENCES OR SIMILARITIES BETWEEN MANUFACTURING AND FIELD OPERATIONS?

The surface of the end face as it passes through various production line operations, typically are cleaned prior to equipment assembly. The strict control and discipline of the production floor is not mirrored in the field. Understandings of field operations personnel range from “any way we clean is good enough” to disciplined, well-trained, production line level procedures. Some OSP operators have upgraded to “zero-debris” over the complete end face.

Perhaps the most significant difference between OEM and OSP/Field Service is in the critical matter of end face inspection. While the OEM approaches 100% inspection, the OSP is often estimated to only inspect 50-70% of connections. “Blind Cleaning” leads to the misperception that all cleaning returns the same result.

Differences between OEM and OSP/Field Service are, by and large, a result of the environment in which the precision cleaning procedure is performed. Both have quality technicians but there is no substitute for ongoing training to match technology updates as an essential key to successful deployment. Standards are critical and the existing ones favor OEM practices. An IEC OSP/Field Service Standard would serve the Industry well.

Be it Fiber-to-the-Home (FTTh) or Fiber-through-the-Airframe (FttA), Fiber to the Node (FTTn) or Fiber to the Tactical Point (FttP), the fiber optic transmission and processes are very much the same. Some transmissions use single mode and others multi mode, some connections are fundamental SC-UPC and others are hardened or expanded beam connections. It is the environment and debris type as well as an applications specific connection that distinguishes and amalgamates virtually all fiber optic connections.

An actual cleaning process for an expanded beam may differ as the contaminant on a ball lens may not require as much detail as a common SC or LC. However, both the

expanded beam and the “Zone-5” concept on a SC or LC have the same concern: contamination migration from outside field of view or active transmission path. While the responsibility of a commercial aviation carrier or DOD operation is immense, there is also a like sense of due diligence for an entertainment, business, 911 network, or, security/traffic control installation.

It is on the production line that the most likely contaminant may be finger oil or possibly light dust as measured in the context of Arizona Test Dust in IEC 61300-3-35. The sense that complex debris is as easy to remove as simple contamination and that one cleaning technique will work as well as another is not at all accurate. Seemingly to assure this, standards suggest multiple cleanings when a first time cleaning technique is as practical as it is desirable. The technician should not have to be a geologist to determine a contaminant type and select from a cornucopia of cleaning products. Neither should that person be a chemist to determine a contaminant. Technicians are schooled to analyze test data and devise a repair. Precision cleaning is a straight-forward science with a clear path to the a simple, efficient task of doing the job right the first time with

The cleaning process should never influence a test and measurement result. A specific ambient is far too varying and debris and contamination likewise, to even begin to assert that most types of debris are one type. Precision cleaning sciences are such that one technique can clean the widest range of debris and accomplish this the first time.<sup>(13,14)</sup>

## WHAT DEBRIS IS POSSIBLE?

As wide a range of contaminants as imaginable should be catalogued. One such estimation was made in 2006 with a series of contaminants from Cisco®. The “Cisco Series” ranged from Arizona Test Dust (ATD) to dried water. Graphite, Simethicone and dryer lint were included.<sup>(6)</sup> In recent times, testing was suggested on dust from Afghanistan, which is remarkably finer than ATD. Beach sand is coarser than ATD; variety is relevant to an effective cleaning technique.<sup>(7)</sup>

In 2011, a second series of laboratory evaluations was conducted at the ITW Chemtronics® Laboratories.<sup>(11)</sup> An added set of debris and contamination was applied to the end face of a 2.5mm UPC connection. In other evaluations 99.9% Isopropyl Alcohol (IPA) was compared to a proprietary HFE-7100/IPA formulation and a second proprietary HFE-7100/non-IPA formulation against a proprietary precision hydrocarbon.<sup>(2,3)</sup>

The debris included IEC Standard Arizona Test Dust and vegetable oil and added an additional ten neat contaminants and debris. (Neat defined as pure, full-strength, unadulterated). The intent of the study was to create worst case debris that would lead to best practice for OEM and OSP