



Fact OR FICTION of Fiber Optic Cleaning and Inspection

1. **T__F__ A Fiber Optic Connector is a Two-Dimensional Structure**
2. **T__F__ 99.9% “Reagent Grade” Isopropanol is an effective fiber optic end face cleaner**
3. **T__F__ Cleaning is not important... anything is better than nothing!**
4. **T__F__ There are OTHER WAYS BESIDES VIDEO INSPECTION to determine “clean”**
5. **T__F__ Debris on a fiber optic connector surface is two-dimensional “diameter”.**
6. **T__F__ Pass/Fail Automatic Detection is “good enough”**
7. **T__F__ Existing standards, such as IEC 61300-3-35, are “Best Practice”**
8. **T__F__ Use the same cleaning products for fusion splice as end face cleaning**
9. **T__F__ 5G Wireless does not depend on fiber optics**



Beyond 2019: Insights Into Fiber Optic Connector Technology

A STUDY FOR DESIGNERS, INSTALLERS AND TRAINERS

Edward J. Forrest, Jr. (Ed)
RMS(RaceMarketingServices)
est:1974
Marietta, ATLANTA, GA. USA
+770-971-8100
edforrest@fiberopticprecisioncleaning.com
www.fiberopticprecisioncleaning.com



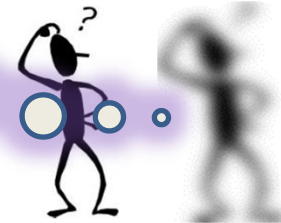
Bringing Ideas Together

Grant Price
Product Manager
ITW-Chemtronics
+800-645-5244
gprice@itw-cc.com
www.chemtronics.com

Why are you here?

We participate in an Industry where fractions of small values (microns and decibels) clearly mean the difference between a successful transmission...and not so much!

Precision Cleaning & Inspection are integral operations:
often mis-understood, mis-stated,
mis-characterized, and, disregarded.



www.fiber optic precision cleaning.com

2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 3

**Some consider this information “controversial”...
even though it’s based on 5,000 years of proven science utilized
everyday in other applications and operations.**

What **IS ‘controversial’ is my challenge to standards
that only update every 8-10 years ... for a medium
that changes ... at**

THE SPEED OF LIGHT!

... the concept of
“The Weakest Link”

2019 BICSI Winter Conference & Exhibition

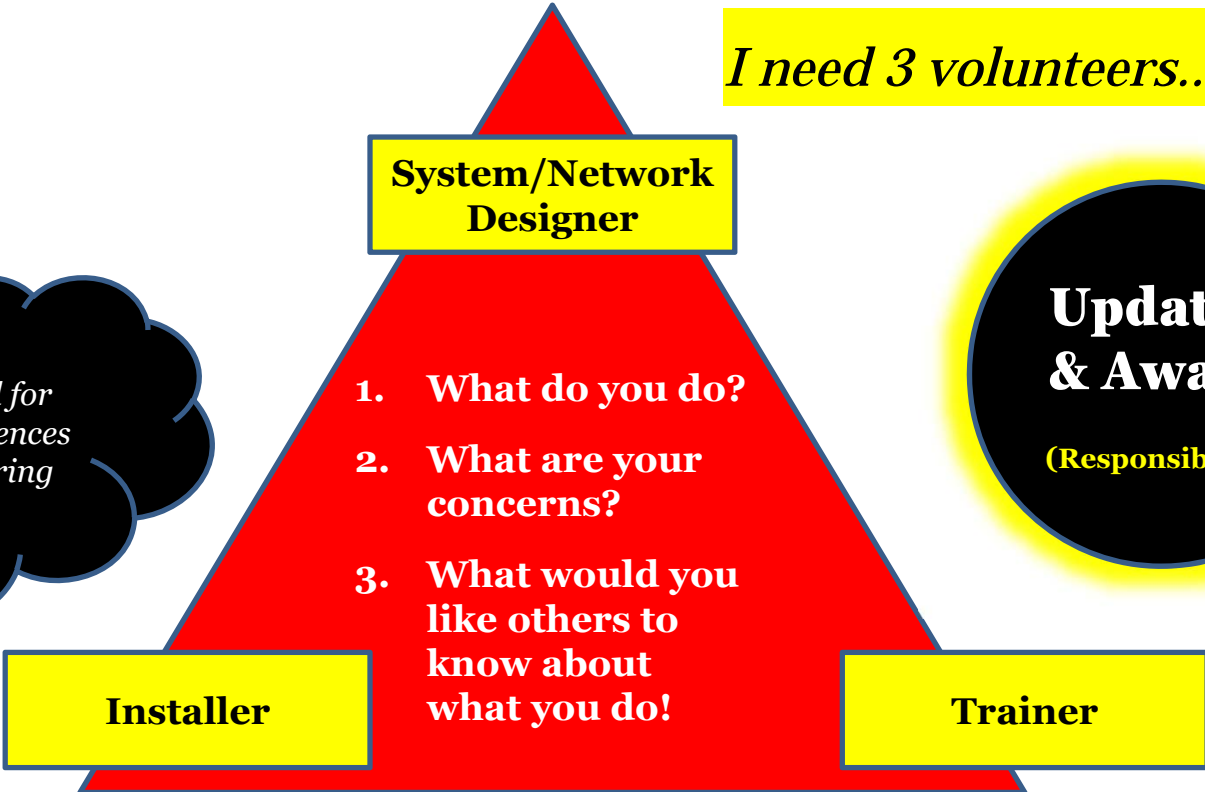
January 20-24 • Orlando, FL, USA

BICSI

Let's Get to Know Each Other!

I need 3 volunteers...please.

You will be asked for your input, experiences and opinions during this session!



Why are you here?

“Future-Proofing”

It's not a buzz-word!

The Industry just ‘finished’ 4G: now we are on 5G!
Even more reliant on back haul...at the speed of light



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

Why is “Future-Proofing” essential?

DESIGNERS, INSTALLERS, AND, TRAINERS

- 1.) Work on varied contracts and ‘must-have’ a common baseline for fiber optic inspection and cleaning.**
- 2.) Precision Inspection and Cleaning is a common thread ... and critical issue for any fiber optic application.**
- 3.) High speed transmission sciences evolve continually ... and can’t wait for 8-10 year ‘standards updates’.**

www.fiberopticprecisioncleaning.com



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 7



NO MATTER THE CONNECTOR TYPE
Direct Contact or Expanded Beam

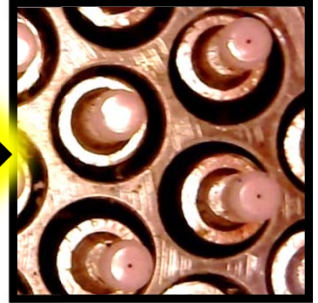
The condition of the fiber and surrounding surfaces ... is critical to successful deployment.

THIS IS CRITICAL COMMON GROUND FOR ANY & ALL.

Digital Photo Images captured on RMS-1© Video Microscope (Patent Pending)

FTTx Data Center

Broadcast Aerospace DOD



1. The transmission fiber doesn't "care" what is the connector type: ***all surfaces must be properly cleaned.*** (The fiber optic transmission surface 'cares' what's contaminating it...how it will be cleaned!)

2. There are precision cleaning methods & procedures (M&P) common ground to all. (This is "The Science of Cleaning")

The "miss" holder. ... holder.

When it comes to precision cleaning and inspection ... there are fundamental tenets applicable to all types.

This is important to you as a designer, installer and trainer.





**Today you will learn there is
such a thing as an
IMPROPERLY CLEANED FIBER!**



Bringing Ideas Together

www.fiberoptiprecisioncleaniing.com

2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 10



Why are you here?

There are five sections to this seminar:

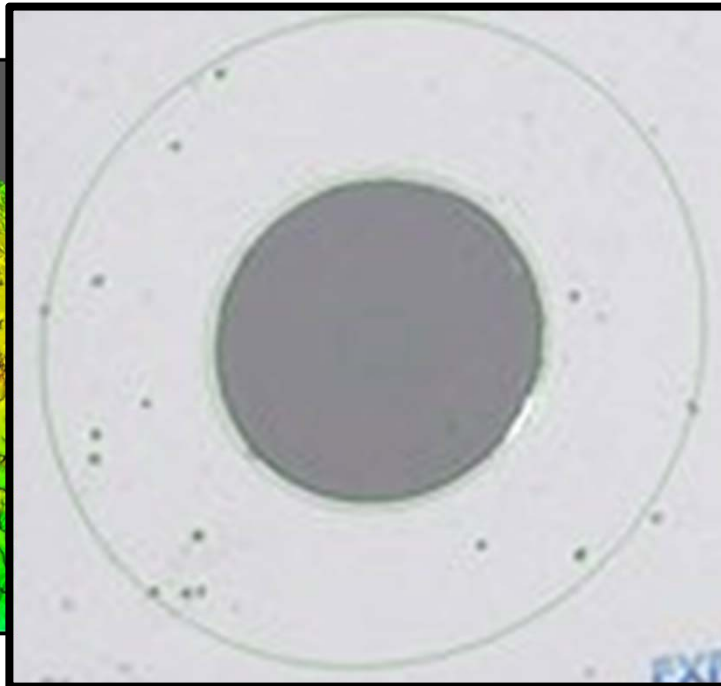
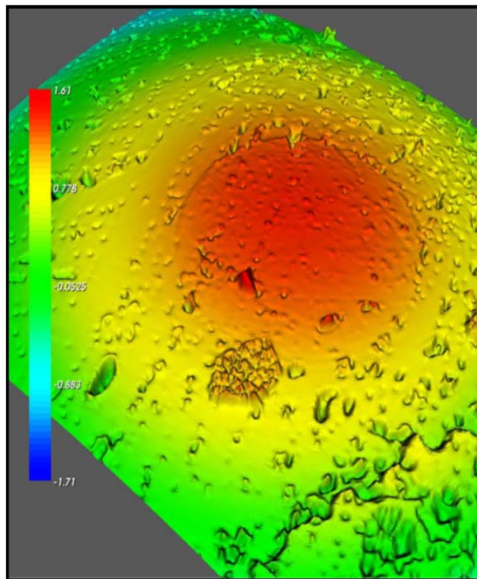
- 1.) The Science of Soil and how this impacts cleaning**
- 2.) The Science of Inspection and how this impacts performance**
- 3.) End Face Cleaning and Fusion Splice Prep and Equipment Maintenance**
- 4.) A Vendor Neutral Product Selection Primer**
- 5.) For special installations: Broadcast, Security, DOD, Storm Damage.**







Part-1 The Science of Soil and How This Impacts Cleaning

Existing Standards Measure Debris & Contamination in “Diameter of 2-D”



Contamination,
in any or all
forms,
is **NOT**
2-D.



- 
- 
- 1.) You are **NOT** sitting there in two-dimensions!
 - 2.) As well...**Connectors and Contamination are NOT two dimensions !**
 - 3.) Best Practice considers **The Reality of 3D** when inspecting and cleaning these surfaces.



Now, of course...there is a 4th Dimension.

- **Time...**
 - **Speed & Accuracy of transmission.**
 - **Cleanliness & Accuracy, for copper, was not as critical...that may change also.**
 - **Fiber Optic Surfaces must be precision cleaned.**



WHAT IS FIBER OPTIC CHARACTERIZATION?

Characterization is a complex process that determine all the

**This is ‘contamination characterization’.
It’s a science not (always) considered
when you design-install-train.**

Part-1 The Science of Soil and How This Impacts Cleaning





How do I characterize contamination ?



How do I characterize contamination ?

There are four fundamental tenets that are ‘burned in’ to each cleaning decision from washing hands to painted surfaces to fiber optics:

- 1.) What is the debris?**
- 2.) Where is it located?**
- 3.) What do I use to remove it?**
- 4.) If I don’t remove it...what happens!**



How do I characterize contamination ?

Fiber Optic Debris is present in at least these ways:

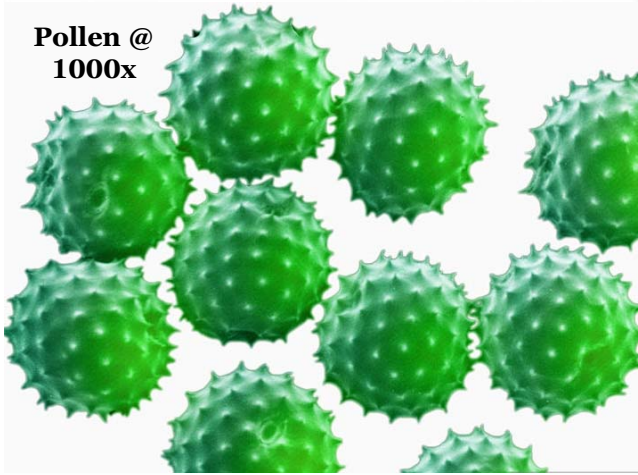
- 1.) It's laying on the surface**
- 2.) It's attached in a micro-polish**
- 3.) It's attached by static field attraction**
- 4.) It's surface bonded**
- 5.) By the nature of debris:
thin/viscous/dusty/combinations**

**This seminar is
intended to
increase awareness
of what can happen.**

***Think of it as
"Plan-B" when what
you've been taught
isn't working out!***

There are three basic types of contamination...with infinite subsets.

Pollen @
1000x

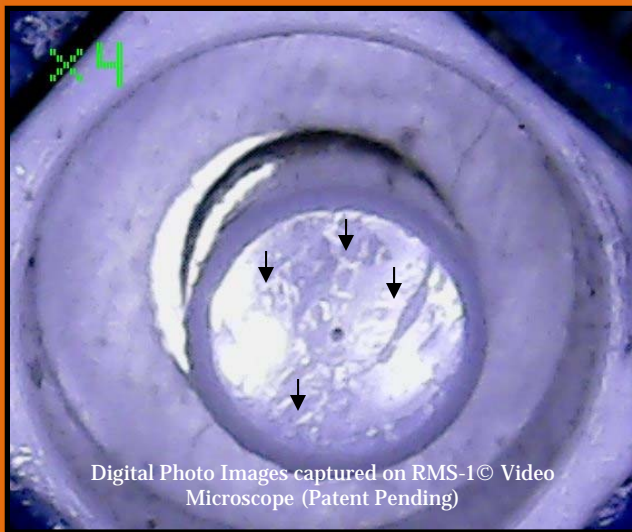


Characteristics of dry debris:

- *Tends to stay in place.*
- *Difficult to remove because of surface bonding or static attraction. Dry water or IPA is difficult to remove.*
- *Imbeds in surface micro polish*



There are three basic types of contamination...with infinite subsets.



Characteristics of fluidic contamination:

- ***Tends to move and not stay in place.***
- ***Difficult to remove, because it moves!
(Can be like 'herding cats!')***
- ***As with all types ... this may be a
fingerprint, hand lotion, a pulling
tube...just to note a few.***



There are three basic types of contamination...with infinite subsets.



**CHARACTERISTICS OF COMBINATION
CONTAMINATION:**

- *Can move as fluidic or stay in place depending on viscosity*
- *Likely most difficult to remove ... difficult to identify.*
- *Likely the most common.*





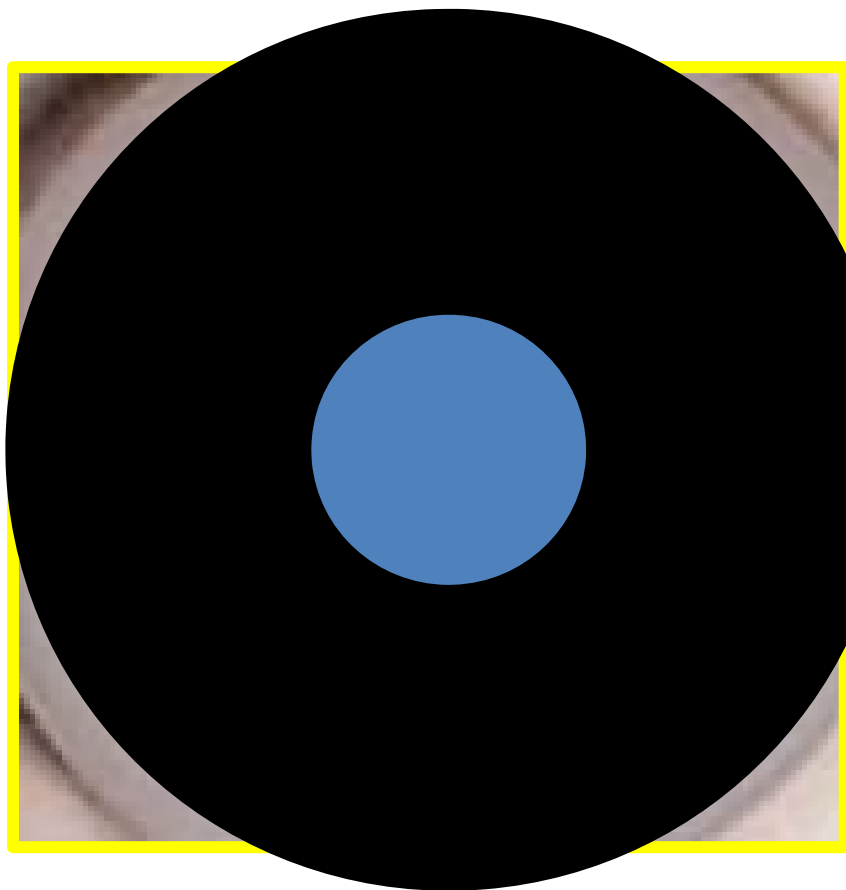
2.) The Science of Inspection and how this impacts performance

Part-2 The Science of Inspection and How This Impacts Performance





**Now that you know
“what can be contamination”...
... let’s look where it may be on the
fiber optic surface.**



What is the “end face”?

- **“Zone-A” ... is the “fiber core”**
- **“Zone-B/C” ... the reflective cladding/epoxy ring**
- **“Zone-D” ... contact surface**

www.fiberopticprecisioncleaning.com

2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

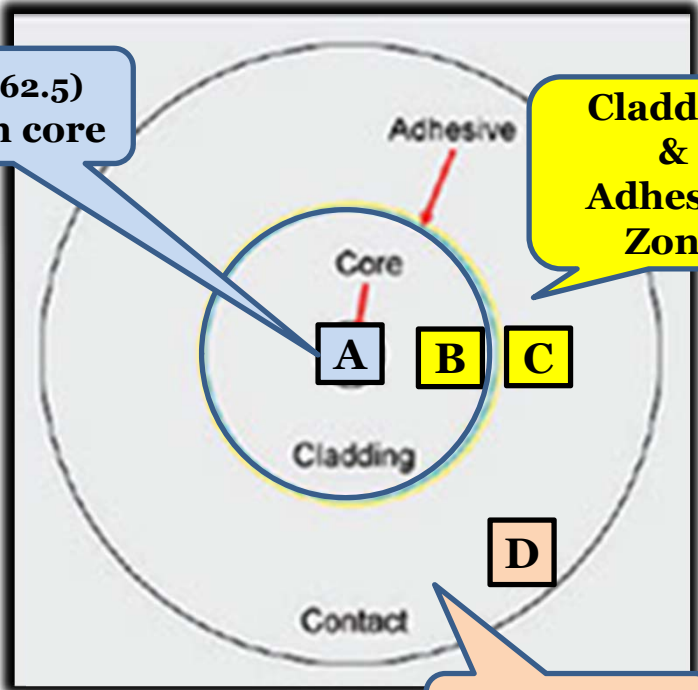
BICSI

For many...this is a review!

The message and lesson for designers, installers and trainers is to consider both single mode and multi-mode fibers as “mission critical”.

Both require proper testing and precision cleaning techniques. If only for creating a “common ground” and simplify: better installation & maintenance methods and procedures.

9 (50/62.5) micron core

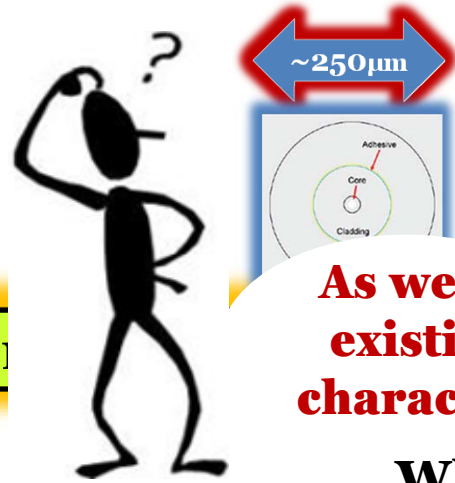


Cladding & Adhesive Zone

Contact Zone



The remaining field-of-view is not seen with existing two-dimensional fiber optic video inspection



As we look to the future...are existing means of fiber optic characterization good enough?

**What about “copper”?
Is it ‘immune’ to corrosion,
galling or fretting?**



“Seems, to me, contamination like this might cause a >fail<.”



Adapter & Alignment Sleeve Contamination
(unseen surface 'geometry')



This connector “passes” all existing standards and tests: it’s contaminated on unseen surface ‘geometry’.

Digital Photo Images captured on RMS-1© Video Microscope (Patent Pending)

Before we get responses: Let's be aware there are actually two fiber optic cleaning procedures.

- 1.) "End Face Cleaning" ... which we have been discussing
- 2.) "Fusion Splice Prep" ... which we'll discuss a little later

As is the case with other applications & procedures ... using the wrong product can result in "less than satisfactory results!"

Brake Cleaner to clean Printed Circuit Boards ...

Printed Circuit Board Cleaner for Brakes....

What does happen is that 'fusion splice' products are used for 'end face' ... or ...



How do you know if fiber optic surfaces are actually clean?

SET THE RECORD STRAIGHT: "WHAT DO I USE?"

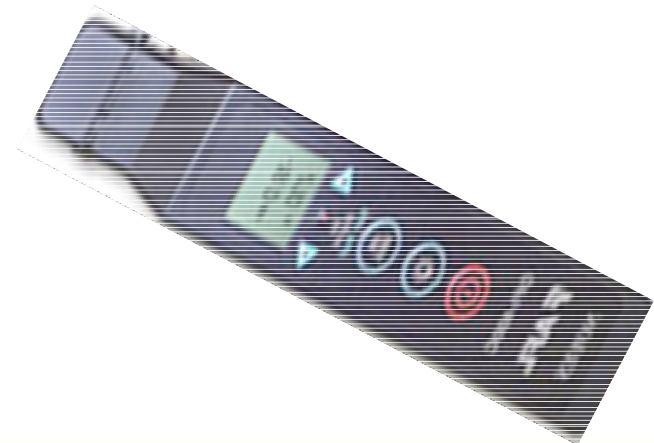
- Fiber Identifier
 - Visual Fault Locator
- Db loss test set (power meter & light source)
 - OTDR?
- Direct view microscope or loupe? **A magnifying glass?**
 - Video Scope?

The Real Question is:
"What Do They Do?"

What does it do?

Fiber Identifier: A Live Fiber Trace and Toner enables the technician to identify available fibers without the disruption of existing subscriber services.

The instrument will not indicate a clean surface



Part-2 The Science of Inspection and How This Impacts Performance



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 31

What does it do?

Visual Fault Locator: A VFL *uses a high power visible laser designed to locate and identify faults and breaks in fiber optic cables, patch panels and other cable splice areas.* They are typically effective up to 7km.

The instrument will not indicate a clean surface

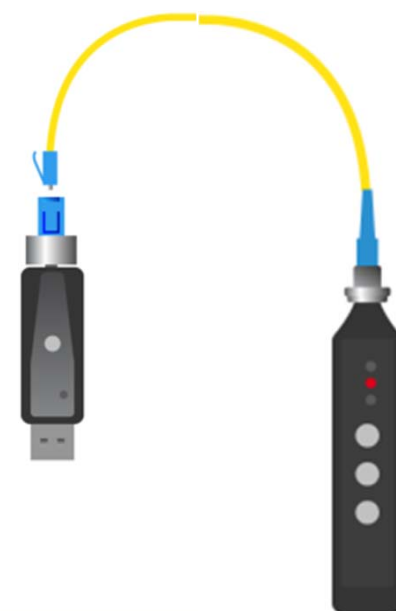


What does it do?

Db loss test set (power meter & light source):

Provides insertion loss measurements...**how much light is lost on a fiber 'run'**

The instrument will not indicate a clean surface



OTDR: What does it do?

#1: A DEVICE TO PRECISELY DETECT FAULTS IN A NETWORK OPTICAL FIBER LINK.

- By interpreting values, the OTDR can indicate a clean or soiled two-dimensional surface.
- It can't measure other sectors of the connector such as adapters, inter-surfaces, or, alignment sleeves.
- It's an excellent, expensive instrument that can be difficult to interpret.



**“Seeing
is
Believing”**

A FIBER OPTIC INSPECTION “SCOPE”

Which one works best?

**The only practical and scientific means to
assure fiber optic surfaces are precision clean...**

Part-2 The Science of Inspection and How This Impacts Performance



2019 BICSI Winter Conference & Exhibition
January 20-24 • Orlando, FL, USA



Consider: “The 4 Classes of Inspection”



Bringing Ideas Together

www.fiberopticprecisioncleaning.com



Class-1: Probe on 125 μm

Some are 400x and others 200x and lower.

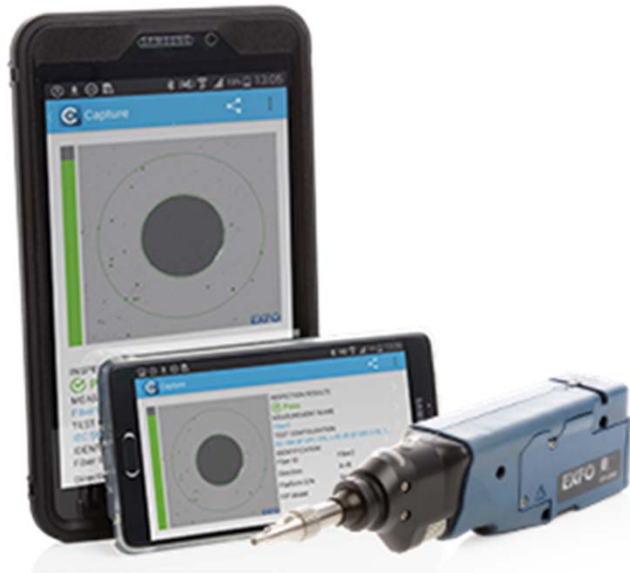
The HIGHER the magnification the LESS of the end face will you see.

The LOWER the magnification the MORE of the end face you will see.

You will learn why that might be a concern.

“Resolution value” is ... very important to “seeing is believing”





**Amazing technology and
convenience.**

**Most are 400x and
*marketed to meet existing
standards.***

Class-2: Wireless/AutoDetect



Class-3:

DIRECT VIEW MICROSCOPE OR LOUPE

- Descended from the 16th Century, the “direct view” microscope, *should never be used on an active fiber.*
 - “Far too often”: Direct View microscopes are used *improperly and unsafely where video inspection is compulsory*
 - My personal feeling: “*Never Trust a Claim these are filtered*”.
- Ideal: QC jumpers...





Class-4: Views 3-D Nature of any connector & debris

New concept features digital photography that observes all sectors of the connector.

Exceeds existing standards.

Up to 200x magnification

Which works best?

- **“Which do I really need”**
 - **“Is one better than another for my training programs?”**
 - **“Can I get by without it?”**
 - (rent one for the job)
 - **“Should I future-proof-the-purchase and buy the most expensive tool?”**
 -
-





3.) End Face Cleaning and Fusion Splice Prep and Equipment Maintenance

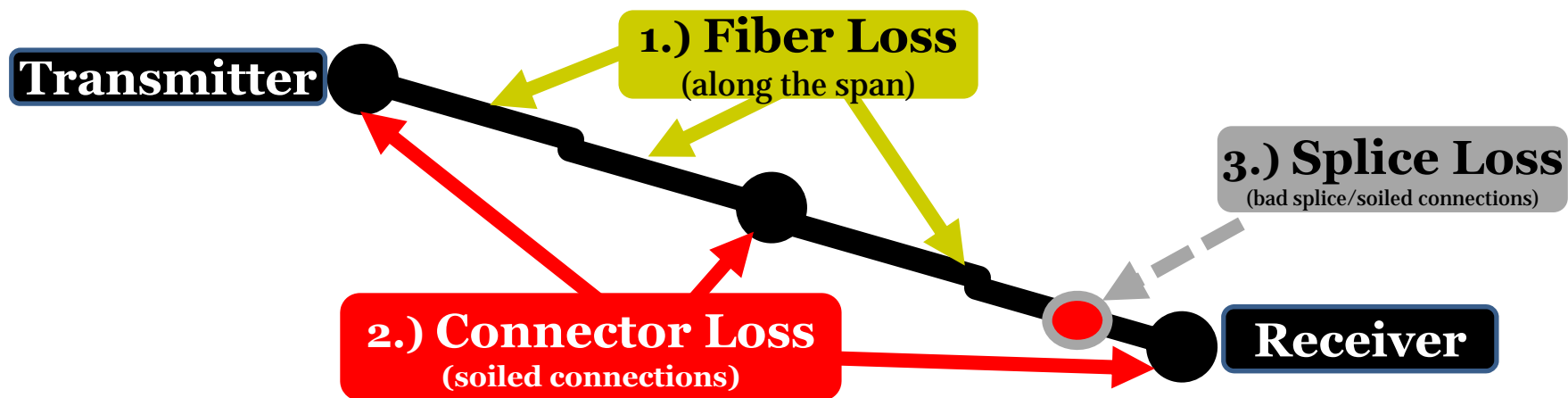


The “myth of two-dimensions” is embedded in fiber optic cleaning, inspection and training standards.

Does it really matter?



**Insertion Loss is a ‘design sum’ total of three components.
It’s an essential calculation in every fiber optic installation.**

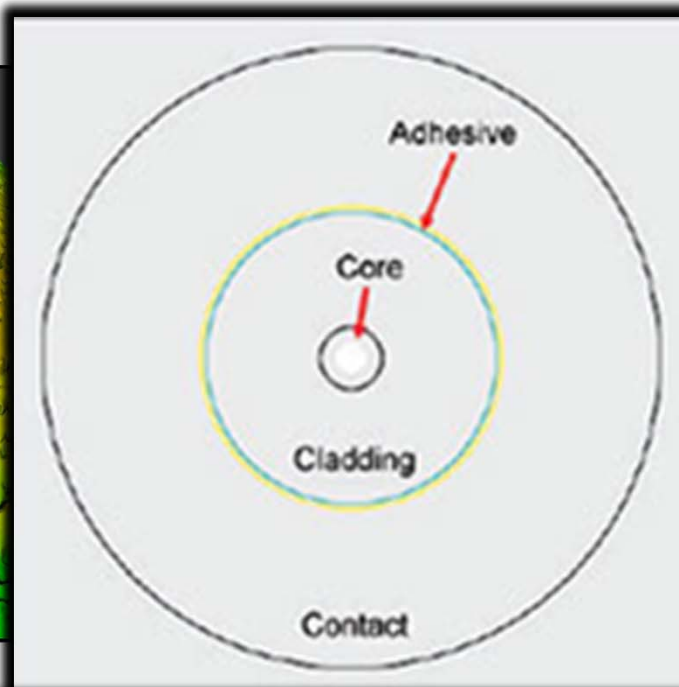
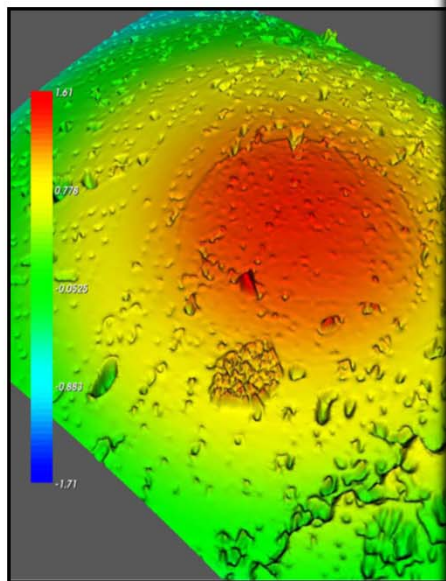


AN IMPROPERLY CLEANED CONNECTION CONTRIBUTES TO:

- a.) Insertion loss and Inaccurate testing based on flawed criteria
- b.) “Reflected Power” can be caused by a soiled or improperly cleaned connector.



Do you recall this interferometer reading?



Standards based on
35 only measure
ns of “diameter”.

μm (often too expensive for FTTx)
res in 3-D.

This dust is 1.67mm high
exceeding criteria for
35 “pass/fail”.

The real science & concern: standards only consider this limited surface area





“...and, your point, Ed?”

Insertion Loss

Dirty surfaces, air gap from worn connector alignment...

Return Loss

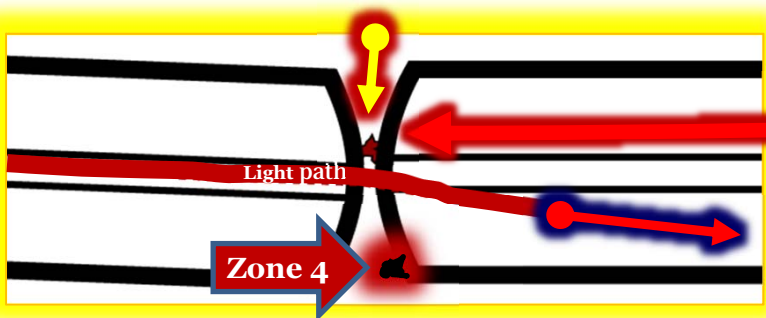
Reflectance of fiber optic light from dirty surfaces, mismatches...

and...

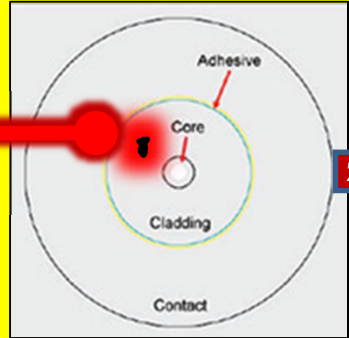


Bringing Ideas Together

1. Misalignment: Debris on the end face can result in a misaligned fiber...



▪ Debris can transfer ... from unseen areas.



2. Equal/greater concern is debris “unseen surfaces”.

(Sure, we’re concerned about the scratch through the “core”...but...how do we know if “the other sector of the connector” has a “problem”?)



▪ **Future Proof your work.**



Introducing a New Concept: Primary and Secondary Contamination

“Pro Bono” White Paper
www.fiberopticprecisioncleaning.com

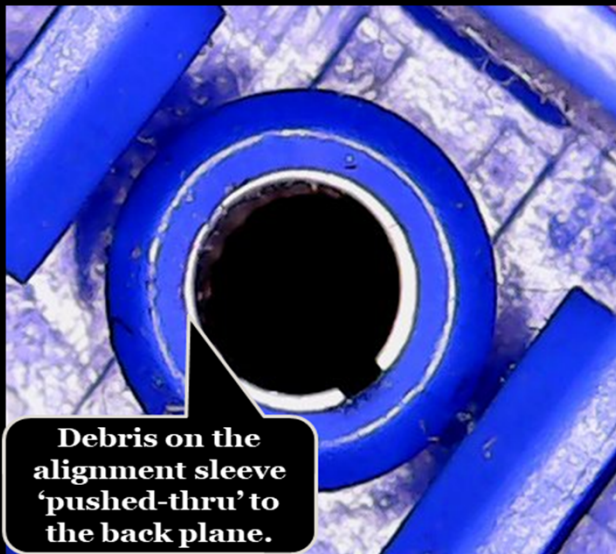


2019 BICSI Winter Conference & Exhibition
January 20-24 • Orlando, FL, USA

BICSI

Cleaning (all) fiber optic surfaces is critical to successful deployments

1

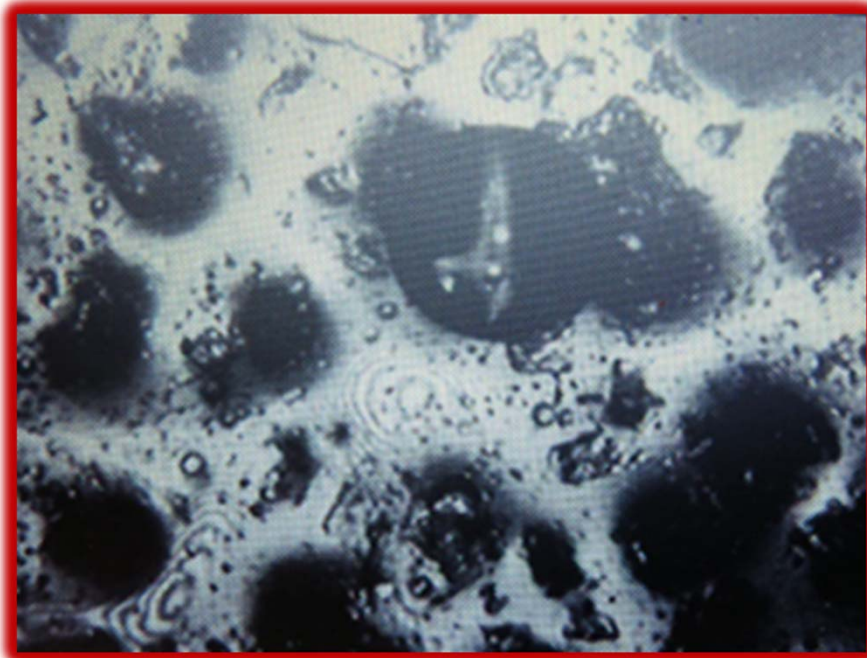


**Of course the fiber end face must be clean. What about the other surfaces?
Have you been taught to understand 'cross-contamination'?**





Heavy Oil/Finger Print @ 400x



**“PRIMARY CONTAMINATION” IS
DEBRIS, AS DEFINED BY EXISTING
STANDARDS SUCH AS
IEC 61300-3-35 REV-2,
AS SEEN THROUGH
TRADITIONAL INSPECTION DEVICES**

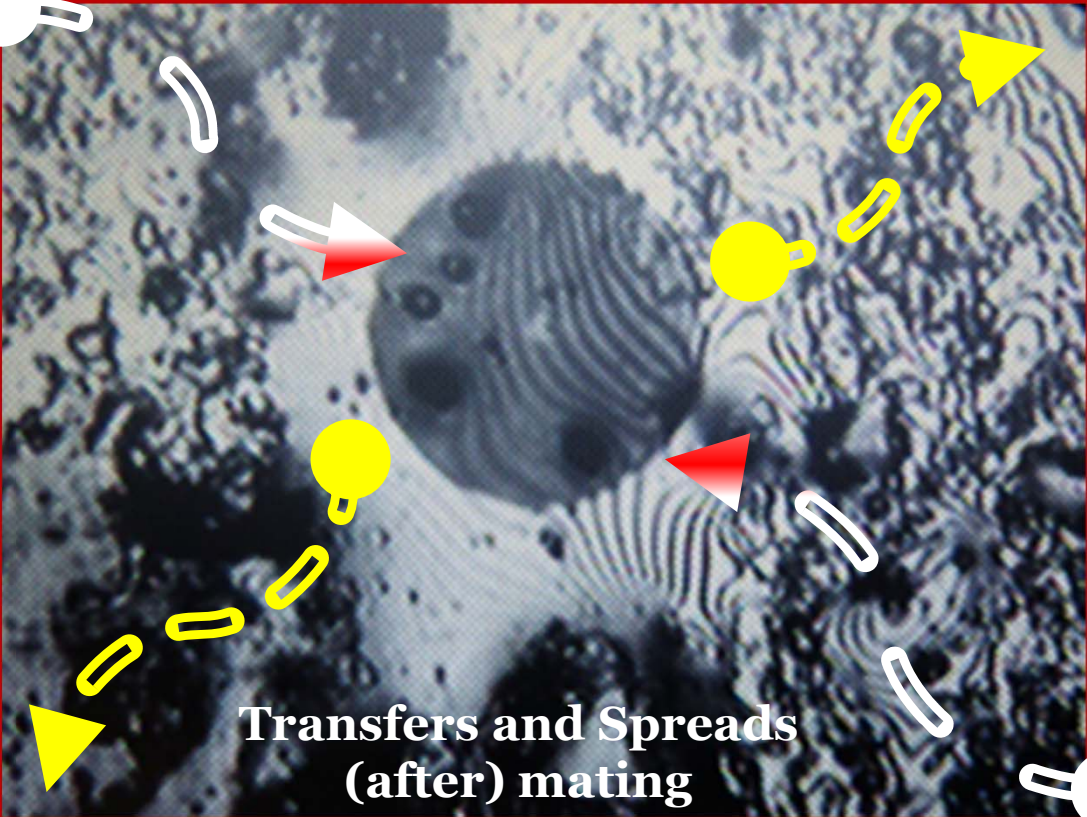


2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 50

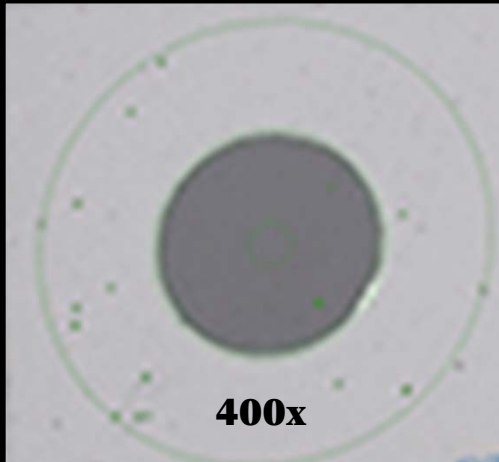
“Secondary Contamination” is debris outside the “field-of-view” that may migrate either by nature of the contamination, or, by nature of compression between mated surfaces



Transfers and Spreads (after) mating



What is “Field of View”?



“Field of View” may be a counter-intuitive thought: *the higher the magnification ... the less of the total surface will be seen.*



“Take-aways”

- a.) **Fiber Optic Connectors and associated surfaces are three-dimensional structures.**
- b.) **Debris is also three-dimensional.**
- c.) **Debris can be located on surfaces other than those seen through most inspection devices. Debris can migrate and cross-contaminate**
- d.) **There are four types of video inspection tools for fiber optic surfaces: select one you can afford, and, one that is “right” in an applications-specific way!**
(Rent one, as a possibility)
- e.) **Trainers: update your courses to match or exceed advances in your field.**
(Did you know? I update this course every year-it's the 5th revision since 2014)





Part 3:

- **End Face Cleaning**
- **Fusion Splice Prep and Equipment Maintenance**



Part 3a:

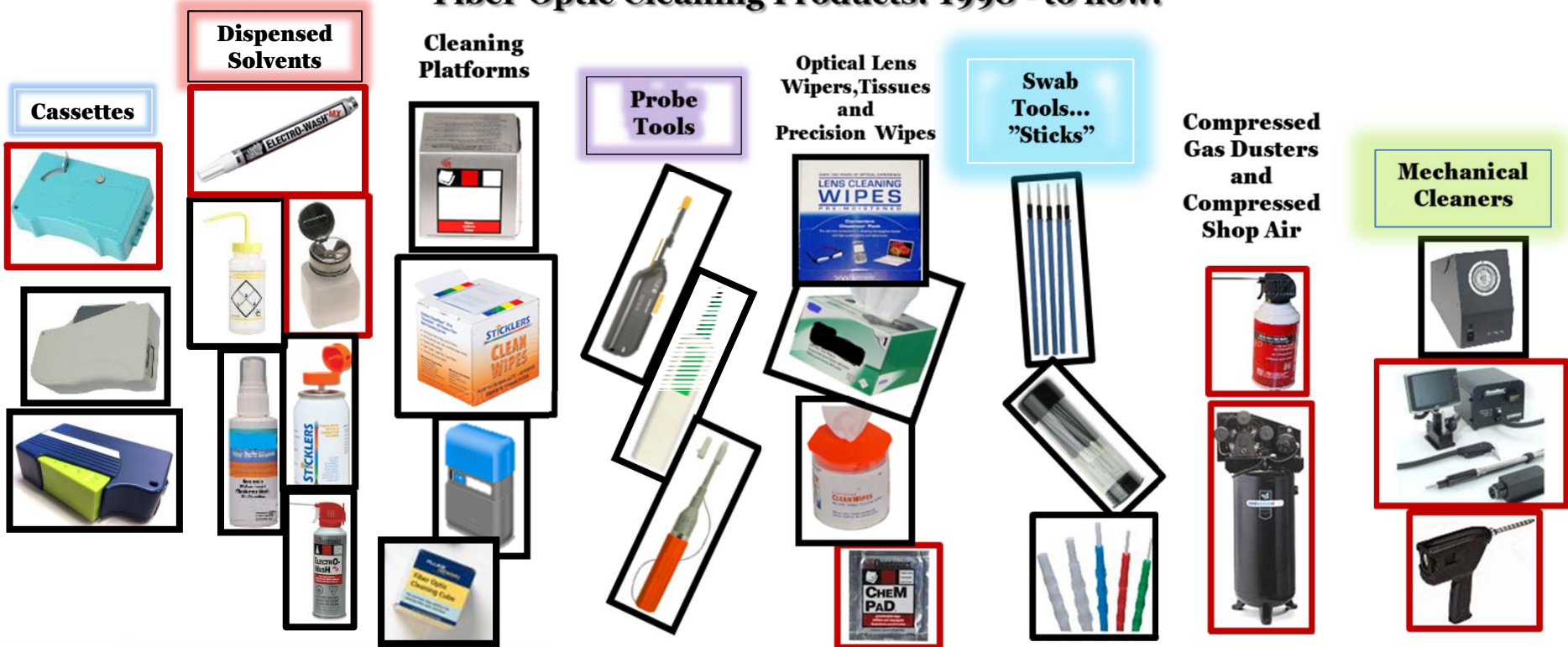
End Face Cleaning

(How do “we” clean fiber optic surfaces now?)

www.fiberopticprecisioncleaning.com

What do you use?

Fiber Optic Cleaning Products: 1998 - to now.



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

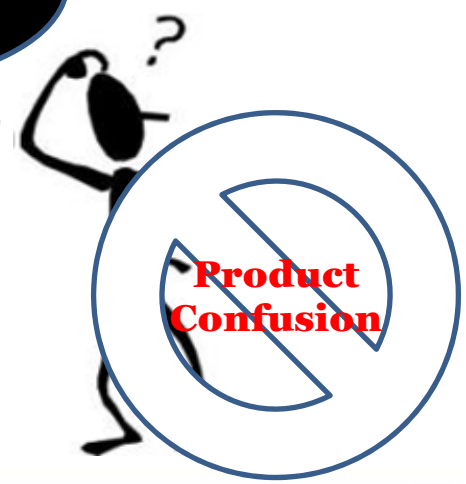
“It worked on my other job!”
“The distributor had a ‘buy-1; get-1’.”
**“Our company does not use the existing standards
... we create our own.”**

- “...cost of acquisition means little because time and money saved with a better process.”

■ “It’s in the...”

■ “It was on sale...”

“ _____ ”





Personally...I don't have a dog in this hunt!

- **However ... I will show you how to make *your favorite product* work better.**
- **This is information **NOT INCLUDED** in the manufacturer's instructions for most of the products on the previous slide!**

What is the standard for precision cleaning a fiber optic end face?

(Remember...we are not talking about fusion splice prep...yet!)

There are actually two IEC Standards.

- **One is IEC 61300-3-35 which calls out the need to clean, inspection...**
- **The other is IEC TR 62627 which details methods and procedures.**

These are “the Mother Standards” from which others are derived.

- ***Some follow these standards and others do not. Why?***

Let's ask our panel...
anyone please help!



Can Standards (and training) be Obsolete and Inadequate?



HOW CAN THAT BE?

New skills are initiated by events like this: Webinars, White Papers, and, study from independent researchers.

Trainers: be sure to update your material: it becomes 'word-of-mouth' *Methods & Procedures.*
(To those who can't attend formal training sessions.)





Caution: This is going to be
**controversial ... even though the information is
based on more than 5,000 years of sciences of cleaning
and 2,000 years of sciences of inspection!**



Who are the long beards and what could they possibly have to do with fiber optics?



***THE SCIENTIFIC METHOD:**

“A method of inquiry based on measurable evidence, experiment, and modification as necessary”

- 1 Euclid, Father of Geometry defined two-dimensions ... about 2,500 years ago.
- 2 **In 100AD^{-ish} the astronomer Ptolemy looked at the heavens and realized there was “distance”. He believed the Sun and Planets moved about Earth.**
- 3 In the 11th Century, while Europe was in The Dark Ages, Islamic scholar Ibn al-Haitham studied eyesight and lenses. His work laid the foundation for ‘The Scientific Method’ * and was widely recognized during The Renaissance.
- 4 **In the late 1400’s, Copernicus set the Renaissance topsy-turvy by writing that the Earth and Planets moved about the Sun. His work set in motion Columbus’ sailing and circumnavigation of the planet.**
- 5 In the 17th Century, Descartes expanded on Euclidian geometry with his work on spheres ... 3-D science we know today.

These are considered ‘mathematical’ sciences ...



Euclid, Ptolemy, al-Haitham, Copernicus, and, Descartes formed the foundation for two others: Max Planck and Albert Einstein.



Early 1900's
Planck's Quantum Theory of Physics revolutionized our understanding of Atomic and Subatomic structures.



“Historical science”, combined with fiber optic sciences, is the foundation for what I propose as a new understanding of fiber optic inspection and cleaning.



Max Planck's work on sub-atomic structures defined them as 3-D ... and tied Euclidean mathematical science to physics!
“Stay with me here for a few minutes...this is 100.5% relative to fiber optic inspection and cleaning!”



Food for Thought:

**For any rapidly evolving technology ... medical,
fiber optic, 5 G, wafer-fab, electrical cars and
Mars Shots ... Cat-8 ... Security ...**

**There ‘needs-be’ a faster way to
“Best Practice” than 5-10 year updates.**





But Wait,
THERE'S
MORE!

Let's Take a 10 minute Break



2019 BICSI Winter Conference & Exhibition
January 20-24 • Orlando, FL, USA

BICSI 66

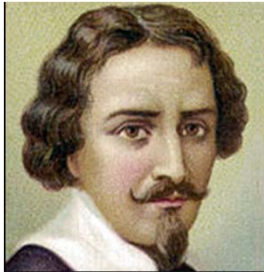


Fact OR FICTION of Fiber Optic Cleaning and Inspection

1. **T__F__ A Fiber Optic Connector is a Two-Dimensional Structure**
2. **T__F__ 99.9% “Reagent Grade” Isopropanol is an effective fiber optic end face cleaner**
3. **T__F__ Cleaning is not important... anything is better than nothing!**
4. **T__F__ There are OTHER WAYS BESIDES VIDEO INSPECTION to determine “clean”**
5. **T__F__ Debris on a fiber optic connector surface is two-dimensional “diameter”.**
6. **T__F__ Pass/Fail Automatic Detection is “good enough”**
7. **T__F__ Existing standards, such as IEC 61300-3-35, are “Best Practice”**
8. **T__F__ Use the same cleaning products for fusion splice as end face cleaning**
9. **T__F__ 5G Wireless does not depend on fiber optics**



This is our history...this is how we started.



...about the year 1590, two Dutch spectacle makers, Zacharias Janssen and his father Hans experimented stacking several lenses in a tube.

They made a significant discovery.



The Janssens invented the compound microscope...
...precursor to contemporary video inspection.

In the same time frame.
Galileo invented the telescope!



**THESE HISTORICAL AND PRACTICAL REALITIES
ARE ESSENTIAL TO PRECISION INSPECTION AND
PRECISION CLEANING FIBER OPTICS!**

1. Existing precision cleaning and inspection standards are based on “Euclidian 2-D geometry”.
2. Ptolemy, Descartes, Copernicus, Descartes, Planck, Einstein and (even) Christopher Columbus taught us ... *what we know as you are sitting there today in the here & now:*

3.

WE EXIST IN 3-DIMENSIONS!





IT'S TRUE:



We are inspecting and cleaning fiber optic connections based on 2nd Millennium (BC) Euclidean Geometry, Ptolemaic Physics and optics invented in the 16th Century!



It's time to ... “GO 21st CENTURY” ...
with our awareness & training
about these things!!!





Techniques for 1st Time Cleaning

Part-4 Vendor Neutral Product Selection Primer

ABSOLUTELY NOT!

Think other ways:

1st: Understand existing standards as minimum requirements: a critical baseline that may not be “best practice”.

2nd: Create your own “Best Practice Standard” in an Applications Specific manner

- a.) Applications-Specific Work Order
- b.) System/Network Designs based on
- c.) Update Training Programs And

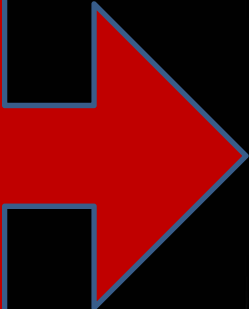
**3rd: Use a “Murphy’s Law” S
Worst Case is Best Practice
Design-Install-Train**



Anything that can
go wrong
will go wrong!



Let's review each ...



- **What if...rather than a standard that fosters cleaning “up to five times”...there was a 1st Time Cleaning Procedure?**
- **What if, there was a procedure applicable to (nearly) all existing products that could result in 1st Time Cleaning? ★**
- **While inspection is critical ... *what if this procedure meant a connection might not require 100% inspection? Plan-B***
- **What if, this procedure began with the designer, passed to the trainer and was used by installers of all connections as a “common ground”?**

★ The term 1st Time is not intended to indicate “perfect” ... just closer than 5 times! A process change is better than replacing a 100’ jumper, or, sending a \$10,000 circuit card for ‘warranty repair’ that only had a dirty or improperly cleaned connector.





Let's take a "deep dive" in a vendor-neutral, non-commercial, scientific way:

THE "SCIENCE OF PRECISION CLEANING & PRECISION INSPECTION".



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

75

“Dry Cleaning a Fiber Optic Surface”

What Does it Really Do?

1



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

76

The Science of Static Field Contamination



This low static charge created this debris.

This is called a “tribocharge”: created when the dry end face is drawn over a dry wiping surface. This would be the same phenomenon for probes and swab tools.



STATIC FIELD
CONTAMINATION
‘DISSIPATED’

Connector did not tribo-charge and attract debris using small amount of fiber optic cleaner on the same wiper surface.

STATIC IS CONTROLLED IN ONE OF THREE WAYS:

- 1.) **Use of an air ionizer:** *impractical for field services*
- 2.) **Use of a grounding ‘strap’:** *no conductive ‘path-to-ground’ using existing cleaning tools*
- 3.) **Dissipation** is the only practical means: ***always use a fiber optic grade solvents.***

“Wet-To-Dry Cleaning a Fiber Optic Surface”

What Does it Really Do?



Physics-101:

Fluids Move and Flow.

(Seems obvious ... but this science
is not considered in existing standards.)



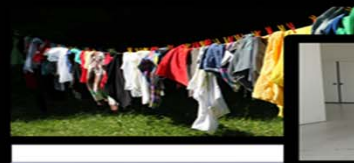
5,000 years ago, The Babylonians invented soap! Since that time, civilization has honed cleaning to a science and commodity. ***We must “hone” fiber optic cleaning procedures.***

“Wet-to-Dry Cleaning”...works best for ‘DRY DEBRIS’.

1.) Dust on an LCD Screen

2.) Dried mud on a painted surface

3.) Dry Debris on a fiber optic surface may be excited to attract more debris by static field contamination.



The Goldilocks Zone:

In recent times, NASA's spacecraft, The Kepler Observatory has discovered what may be many thousands of planets in "The Goldilocks Zone": not too hot and not too cold to sustain life as on Earth. **Something "just right".**

There is also a "Goldilocks Zone" when considering fiber optic precision cleaning and inspection: too little or an incorrect solvent and wiper combination: *the debris will not be removed*. Too much and *the surface will be damaged*. Inspection.

Through

Since I can't see beyond 250-300 microns on a horizontal surface ...

How do I know? What's the 'safety net'?
Is there a "Plan-B"?

Think about it: Using something that works best on debris that is "dry".



This is the Science of Hydrology*: *the attraction and absorption of dry matter by fluids...and fluids into dry matter.*

*Professor Tyson Ochsner: Oklahoma State University
Paul Blair: ITW Chemtronics®



For me the standards' instructions: "...dry clean first, followed by wet-to-dry..." are vague, at best.

Worse: instructions are practically and scientifically bass-akwards!
(unless you want to clean up to 5 times!)

**"DRY CLEANING" WORKS ON "WET CONTAMINATION" AS A MOPPING ACTION.
"WET-TO-DRY" CLEANING WORKS ON "DRY DEBRIS".**

"Words have meaning"

Technicians of all skill levels are managing these deployments and may have been taught in 'hand-me-down, word-of-mouth fashion'.



WHICH DO YOU

“What if...” a slightly different procedure ... relative to all (just about) tools ... eliminated “Confusion of Choice”.

What if...Precision Cleaning is not about the cleaning tool...but a process change?





Between 2003 and 2014 this demo was performed at various events...about 15,000 times.

Adaptations of this technique work on probe tools and precision swabs.

The 3rd Process is deceptively simple and leads to Best Practice and 1st Time Cleaning of all connector types.

The procedure also helps define other sectors of the connector may be contaminated and cross-contaminate fiber(s)

This process was developed and patented in 2005 by ITW-Chemtronics[®]. It has major formal approvals. Some, such as Fluke[®] now suggest this technique.



IN 2006 CISCO® ISSUED AN INTERNAL STANDARD FOR CLEANING A FIBER OPTIC CONNECTION.

It was an important document that tested widely varied debris and contamination from the 1998 and then pending 2008 IEC standards.

Contaminants included:

- 1.) Vegetable Oil**
- 2.) Metal Shards**
- 3.) Graphite**
- 4.) “Duffy Dryer Lint”**
- 5.) Simethicone**
- 6.) Arizona Road Dust**
- 7.) Dried salt water**
- ...total of ten.**

These are difficult, complex soils

These are not new ideas

A successful cleaning was one that removed the debris ten successive times over the complete end face

To achieve this high percentage of 1st Time Cleaning researchers used the 3rd process standardized in Telcordia GR 2923-Core (2011)



The “soils” in my follow-up study and The Cisco Series® are far more difficult to remove than those used in the IEC Standards.

“Worst Case leads to Best Practice”.

I encourage Designers and Trainers to consider the types of debris that may be encountered at the installation site: include in your designs in an applications-specific mindset.

There are only two or three bona fide fiber optic cleaning producers: check with their tech support. The Distributor is a supply source...but not always an adequate technical resource.





The Scientific Method: What Did This Study Achieve?

- 1.) **Determine that 1st Time Cleaning can be: reality**
- 2.) **“Push” existing procedures from minimum-requirement-standards ... to a new “Best Practice Standard”.**
- 3.) **Provide a procedure for those technicians ... ‘exiled’ to blind cleaning!**





4.) A Vendor Neutral Product Selection Primer

We just stocked our
warehouses ... don't tell me
we have to send it all back!



www.fiberopticprecisioncleaning.com

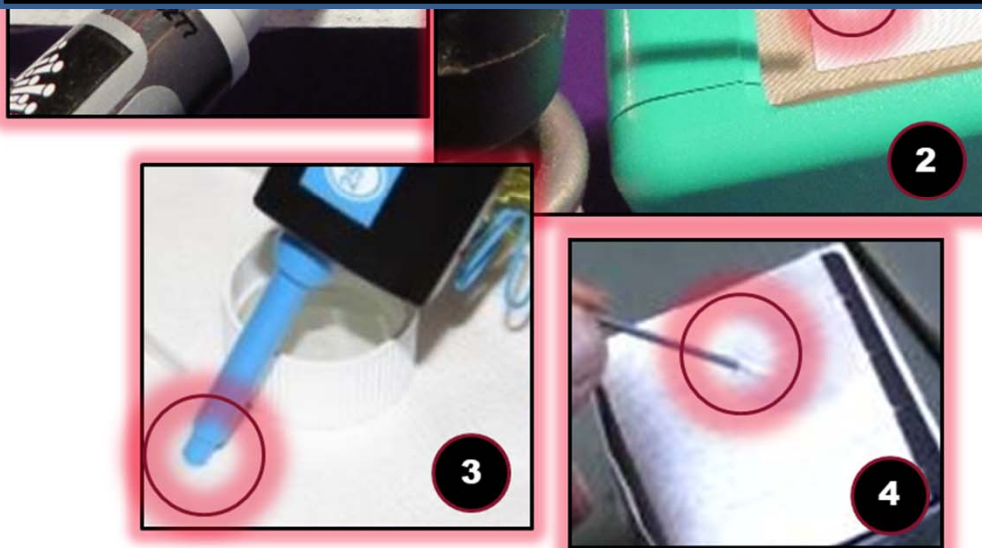
2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

87

The New Generation of Fiber Optic Solvent Cleaners use far less...to achieve more.



fiber optic cleaner. No IPA!

- 1.) Moisten the cleaning platform surface
- 2.) Lightly moisten 'reel cleaner' tape
- 3.) Depress the probe tool to moisten the cleaning tip. *Don't activate ... if it "cliks" the solvent won't be in the right place!!*
- 4.) Hold the Probe or Swab tip in the moist area for a count of 1-2-3-4-5.

**Contemporary Precision Cleaning is
'all about' using less to do more.**



Eliminate Confusion of Choice of Products.
Change the Cleaning Procedure.



What Works!

This group of products always used with precision fiber optic solvents is “Best-Practice”



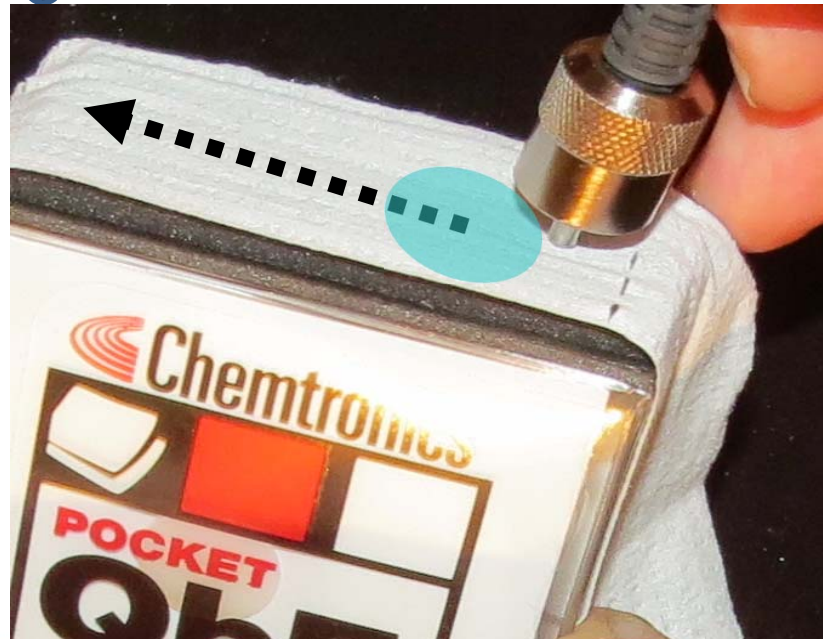
- ✓ **Ask your rep!**
- ✓ **Request Samples & Training**
- ✓ **Challenge the factory!**



Some “Do” of Precision Cleaning.

Lightly draw the end face from the solvent spot to the dry area.

This is
The Original
“wet-to-Dry”
technique
developed in
2003



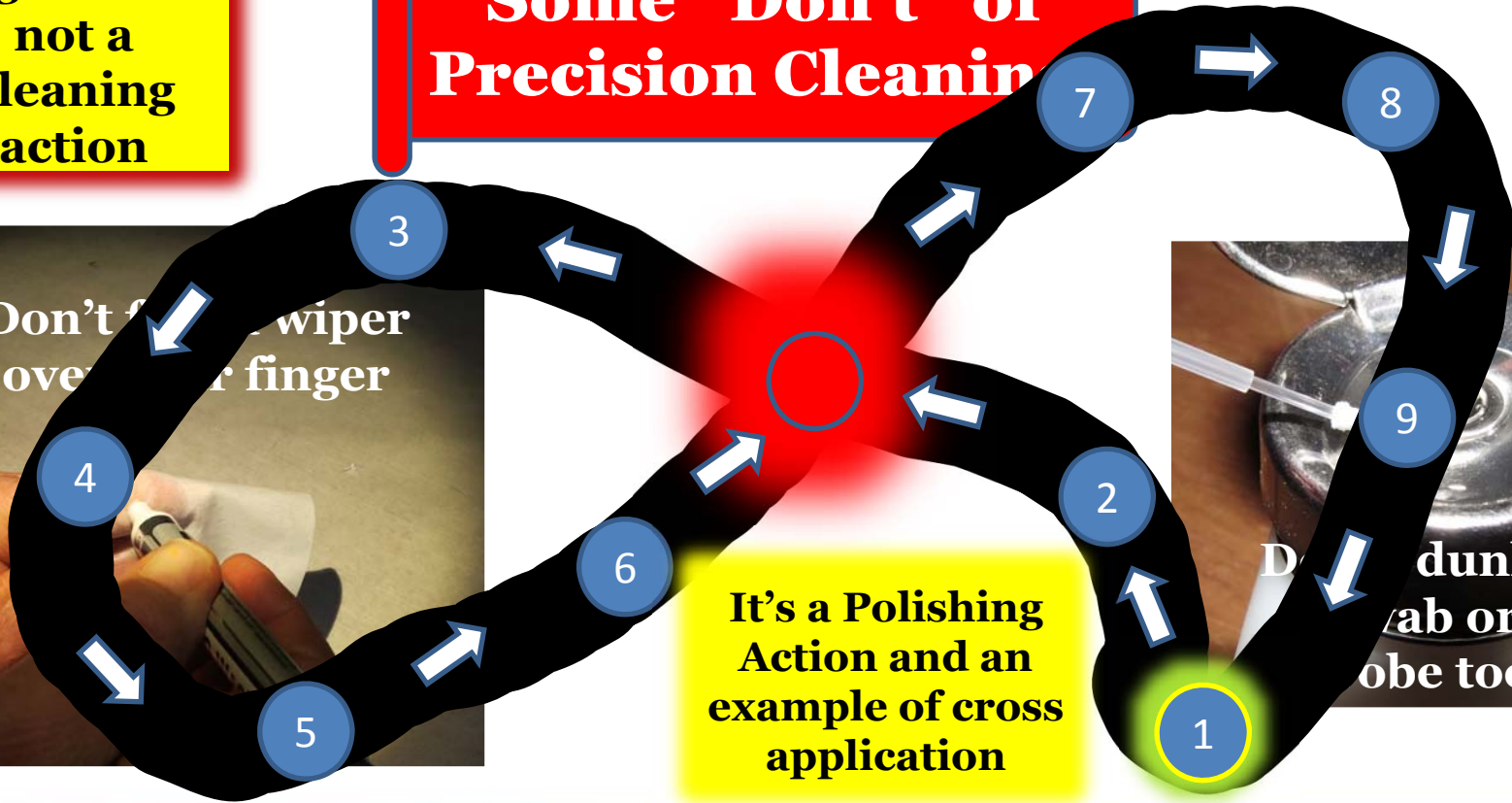
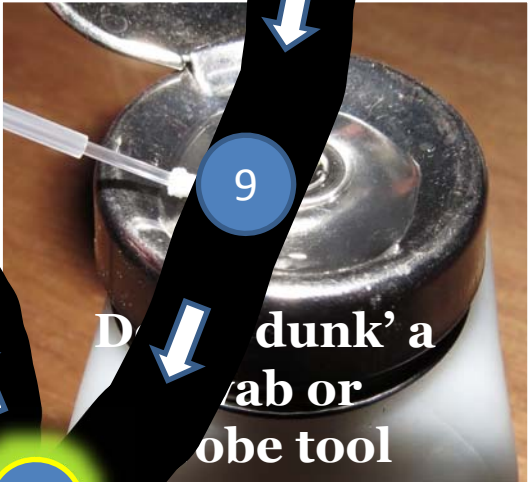
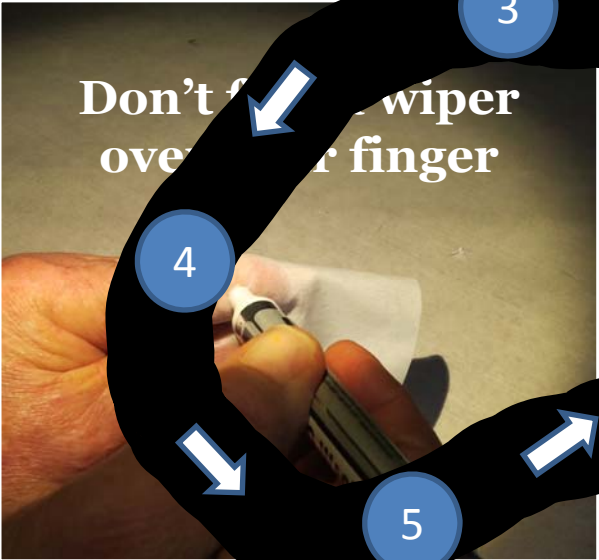
This means
that a “probe
tool” should
be clicked at
least twice:

The 1st time to
wet the
surface and
2nd time to
dry.



Figure-8 is not a cleaning action

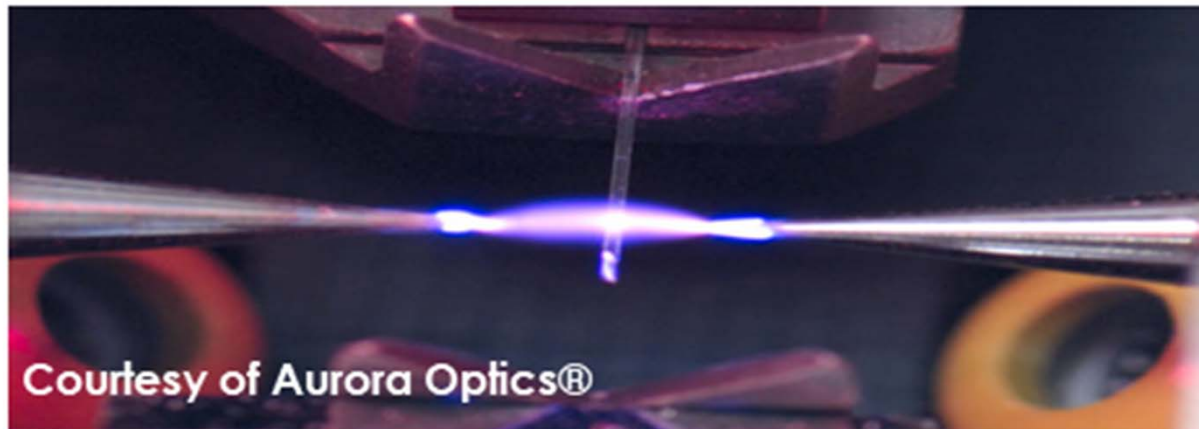
Some "Don't" of Precision Cleaning



It's a Polishing Action and an example of cross application



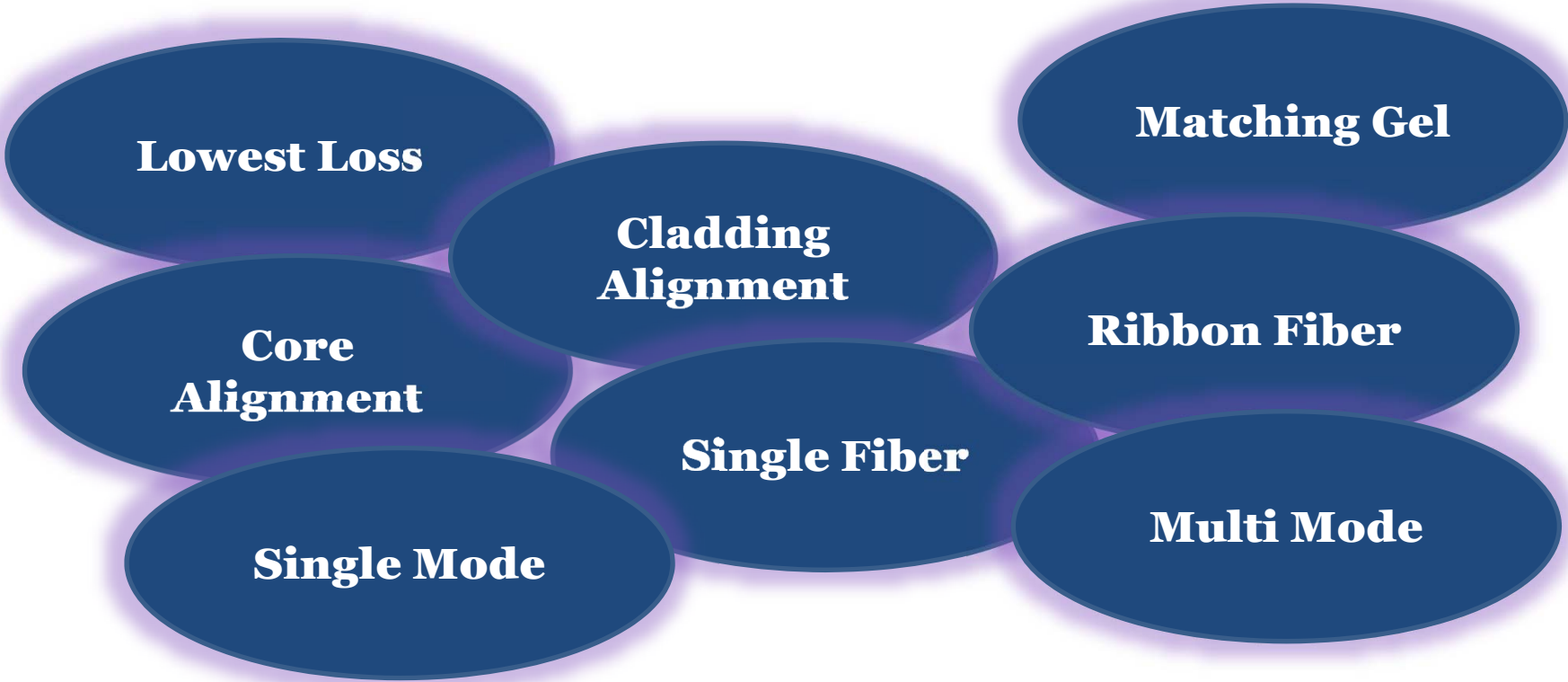
3b.) Fusion Splice Prep and Equipment Maintenance



Bringing Ideas Together

What is a “fusion splice”?

3b.) Fusion Splice Prep and Equipment Maintenance





The Contemporary Fusion Splicer is a marvel of electronic and mechanical accuracy.

Most machines achieve .02db easily and perform the procedure **The First Time.**

In the “old days” * ...

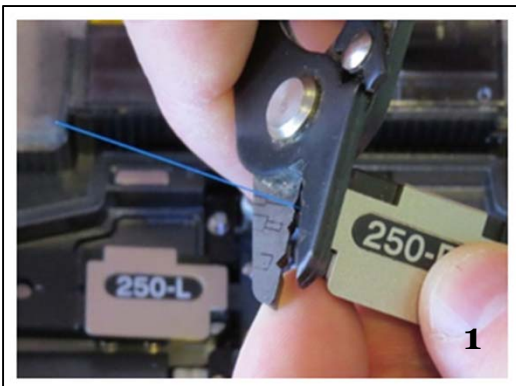
“Thanks” to Chuck Mason-TelRep Marketing and Darrin Newman at Fujikura

2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

94



Ask the supplier for cleaning suggestions for mechanical and hot strippers



“Stripping” and “MidSpan Break-in”

1.) Mechanical Tools for single fiber

2.) Hot Strippers for ribbon and single fiber

3.) Chemical ‘mid-span’ break in for ribbon

Ask the vendor: “Is this the latest technology?” “Do you have formal approvals?”



It's at this point our focus turns to 'prepping' the fiber for the actual splice.
(The arrow points to a bare fiber cleaned with a non-paper wiper and a non-IPA cleaning solvent.)

However, prior to that, the equipment must be properly cleaned.

This is a precision device that likely has a specific number of cuts before the blades are replaced.



“... a bare fiber being cleaned with a non-paper wiper and a non-IPA cleaning solvent.”

There is one very important commonality between “end face cleaning” and “fusion splice prep/equipment maintenance.

SELECTION OF HIGH-PERFORMANCE PRODUCTS THAT MEET THE TECHNOLOGY OF TRANSMISSION SCIENCES.



Even 99.9% (Reagent Grade) IPA is **not** an effective cleaner on the wide range of contamination in “deployment” and “splice” applications.

99.9% IPA is “hygroscopic”: it attracts moisture to itself. This diminishes an already weak cleaner.

‘labroom’ in this pump bottle induces moisture and contamination.

When someone mentions “hygroscopic” ...this is what it’s all about: proper storage.

... lint on fibers and splice surfaces.

Wipers can disintegrate in solvents.

Perform a simple ‘tear-test’.
If the wiper easily separates ... it is not appropriate for precision cleaning.



1.)

Often overlooked components of fusion splicers are

On other equipment styles, the lenses

Each component of the fusion splicer acts in harmony to deliver a low loss first time splice. If your equipment has been in "severe duty", it's best practice to clean each

**EACH COMPONENT OF THE CONTEMPORARY FUSION SPLICER WORKS
IN HARMONY WITH THE OTHER.**

Be certain you follow manufacturer's guidance. Also check with the independent producers of precision cleaning tools who focus on updates and *exceeding* standards.

**The swab tools that you see on this slide are NOT "sticks"
...they are precision cleaning tools.**

are selected for each application: none are cotton.

What are some options?

**Cleaning
Platforms
&
Reel Cleaners**

**Probe Tools
&
Precision Cleaning
Swabs**

**Compressed Gas
Dusters (Canned Air)
& Pre-saturated
Wipers**

**99.8% "Reagent
Grade" IPA
&
Fiber Optic
Precision Cleaners**



Cleaning Platforms & Reel Cleaners



Cleaning Platforms and Reel Cleaners typically use non-woven hydroentangled cellulose/polyester or microfiber wipers.

Select a brand that has a new integral platen⁽¹⁾ with each container. A compliant surface is far better than hard rubber or 'air support' system. Product details matter as speeds and capacities are impacted by not only debris...but also improper cleaning techniques. Some containers are plastic which can generate static.



Some tools use a rubber platen that is never changed

⁽¹⁾ The platen is the cleaning surface under the wiper.

**Cleaning Platforms
&
Reel Cleaners**

Panel of Experts:
*What Do You See as the
differences?*





**Cleaning Platforms
&
Reel Cleaners**



1.) Up to 3” cleaning surface allows debris to be moved **away** from initial point of contact.

2.) Easier to moisten

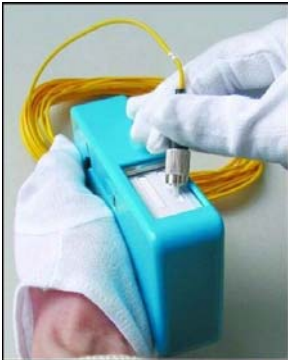
3.) Cleaning platen (under-surface) new with each tool.

Provides a compliant/protective ‘ride’ for the end face

1.) Smaller, more convenient footprint fits in pocket

2.) Auto advance assures same wiper is not reused.

3.) Some re-fillable versions. Under-platen not replicable: can grind dust into end face surface.



Probe Tools & Precision Cleaning Swabs



Procedure Evolution

The Probe Tool Revolution



**Probe Tools
&
Precision
Cleaning Swabs**

Which Tip?



Procedure Evolution

Both 'hard-polyester' and medical grade foam absorbed test dye. Foam is more absorbent than 'pull-truded' or 'sintered polyester' hard tips.

This medical-grade foam tip **DOES NOT** clean on the *end of the swab head.*

Since the polyester tips are flat and hard, they always should be moistened. **Don't grind dry debris into an end face surface.**

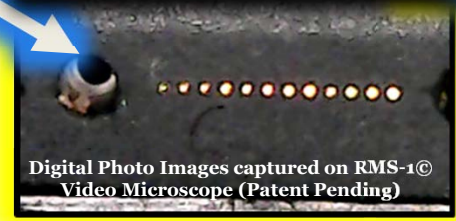
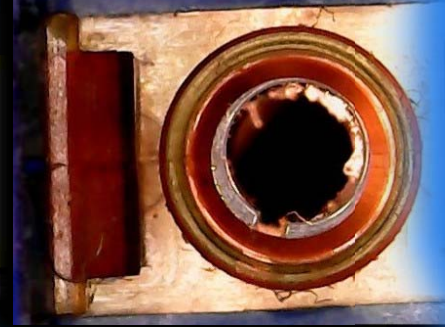
The 'blade-tip' (used on upper-left design) folds-over and presents a larger, more absorbent, and, compliant surface.

Probe Tools
&
Precision
Cleaning

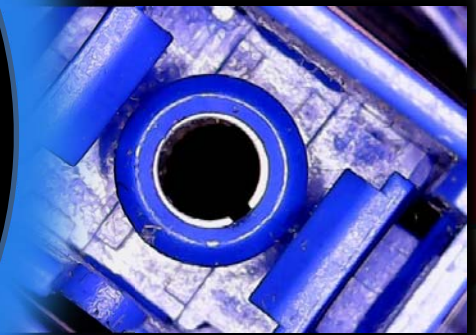
Tape
mm



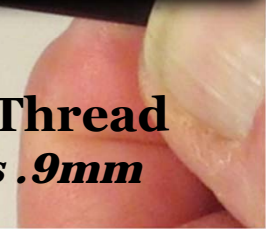
Select
cleaning tools
with an
“applications
specific
mindset”.




S
“align
fer
alignment



Cleaning Thread
measures .9mm





**There are important details in the “Sciences of Precision Cleaning”
proven over hundreds of years.**

**In recent times, highly sophisticated applications in high value clean
rooms (wafer fab, pharmaceutical, medical device and interstellar aerospace)
use precision swab tools. *You will find these precision tools are cost effective
and high performing...because this industries use lots & lots!***

**Challenge the manufacturer:
be aware a swab is not always a Q-Tip® and surely not a hard stick!**

www.fiberopticprecisioncleaning.com

2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

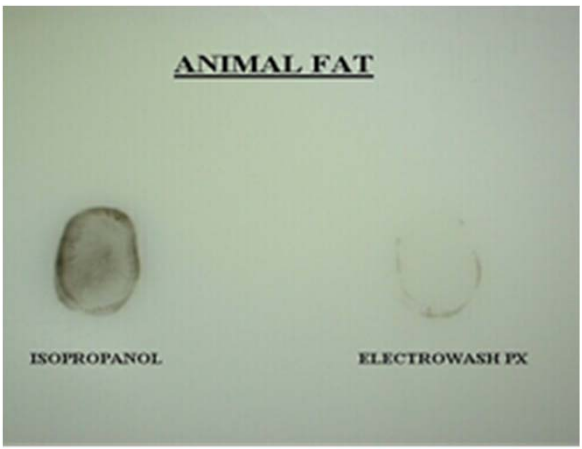
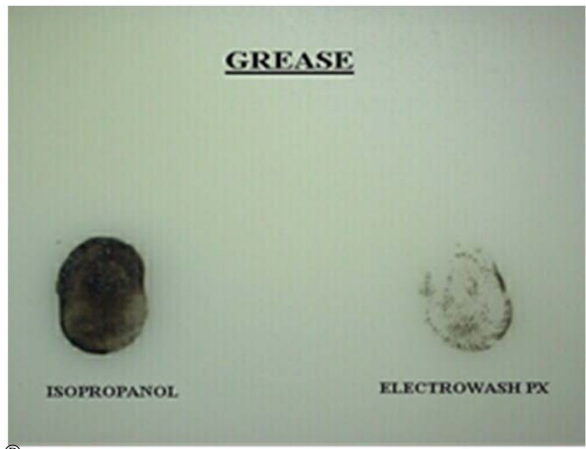
BICSI 106



**99.8% “Reagent Grade” IPA
&
Fiber Optic Precision Cleaners**

The MYTHS of Cleaning Products

“99.9% Reagent-Grade Isopropanol (IPA) is an effective fiber optic cleaner”
Here test compared to a Fiber Optic Grade “Precision Hydrocarbon”
(with RBOC/CATV Formal Approvals)

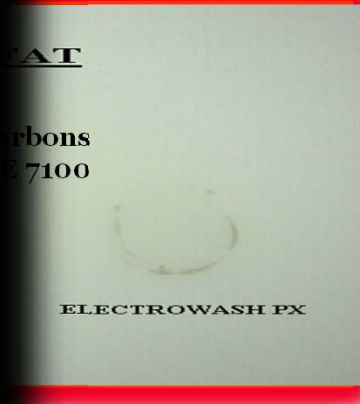


With Appreciation to Chemtronics@_

99.8% "Reagent Grade" IPA & Fiber Optic Precision Cleaners

The MYTHS of Cleaning Products

Non-Flammable Fiber Optic cleaners



Please contact Chemtronics if you would like a copy of these formative 2003 tests.

BY THE WAY:

**99.9% IPA is 'acceptable' for fusion splice prep ...
it's end face cleaning that suffers.**

1. There are superior non-IPA 'fusion splice prep' solvents. It's thought that moisture from IPA can *cause premature corrosion of splicer electrodes.*
2. Reduce your chemical inventory: **ELIMINATE CROSS-APPLICATION OF SOLVENTS.**

**Designers: specify. Trainers: Update.
Installers: Future Proof to Best Practice.**



“Fiber Optic Grade Cleaners”

Marketing Claims and Reality

Pens, Pumps, Aerosols

Fiber Optic Grade Cleaners, along with those in other Industrial Segments, evolved beginning in 1999 with International Regulation eliminating CFC's.

These are exceptional cleaners...worthy of our Industry.

Check Out new “Aqueous” formulas



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI 110

**Compressed Gas
Dusters (Canned Air)
& Pre-saturated
Wipers**

**Products to use with
discretion & caution**

**Compressed Gas
Dusters (Canned Air)
& Pre-saturated
Wipers**



By the way, it is NOT
“canned air” and
suggestion it’s a
scuba tank is
dangerous!!!

Compressed Gas Dusters are not recommended for end face cleaning simply because they are not effective.

Compressed Gas Dusters are not recommended for fusion splice applications because the ‘blast’ of compressed gas can launch a shard of glass...safety hazard.



“Pre-Saturated” and certain “dry wipers.



If the wiper is used for an “optical lens surface”, (microscopes, eyeglasses, camera lenses) it’s not acceptable for fiber optics!

Use these wipers for “cosmetic” cleaning of equipment surfaces ...they are not fiber optic grade. (No matter the marketing claim.)



**The Previous Section is not about
one product or another.**

**It is about Methods and
Procedures.**

As was said early →

**Updated
& Aware**
(Responsibility)

**Designers-
Installers-Trainers**

(Remember? I update my training every year)





5.) For special installations and circumstances:

**Storm & Water Damage
Broadcast and Security
DOD & Aerospace**



Bringing Ideas Together



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

BICSI

115



**From catastrophic event...to a pedestal left open
and doused by a sprinkler...water plays havoc with
electronics and connectors.**

With Appreciation to Chemtronics®_

- Most are surprised to learn that contemporary electronics are produced using ‘aqueous cleaners and fluxes’: **electronics are often born in water!**
- **WATER AND STORM DAMAGE CAN BE A ‘TROUBLESOME ADAPTATION’ OF PROCEDURES THAT MADE A FIBER OPTIC (OR COPPER) SWITCH, ROUTER OR CONNECTOR!**
- There are new fiber optic cleaners...some aqueous and others of composed of 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy and 2-(difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoro-

“There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.” (SDS-direct quote)

**Chemical cleaning is an ever-advancing science: ask your supplier “what’s new”.
Seek producers of precision chemicals.**

(Learn how to read Safety Data Sheets {SDS} and Technical Data Sheets {TDS}. The manufacturer will instruct you.)

Challenge private label re-packages. Remember...your distributor may not be the best source of technical information: speak to the manufacturer or the manufacturer’s rep. Understand what you are buying and using.





Cleaning Fiber Optic Storm or Water Damage.

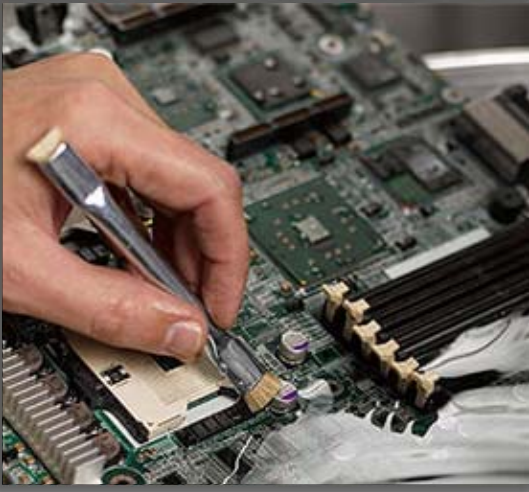
There are three fundamental tenets that are ‘burned in’ to each cleaning decision from washing hands to painted surfaces to fiber optics:

- 1.) What is the debris?**
- 2.) Where is it located?**
- 3.) What do I use to remove it?**

Return to the likely production process.

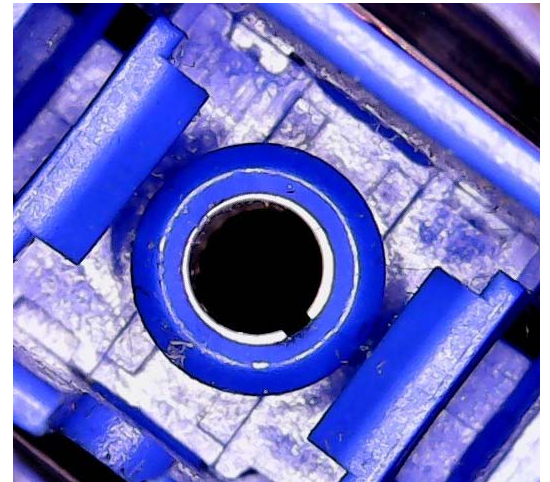
With Appreciation to Chemtronics®_





Step-1 Rinse with de-ionized water

(Easy for you to say...where do I get 'deionized water in a flood zone?)



With Appreciation to Chemtronics®_

Step-2a Remove Water and Moisture with the correct choice of
1.) a cleaning solvent followed by
2.) compressed gas duster with high velocity and ‘all-way valve’.

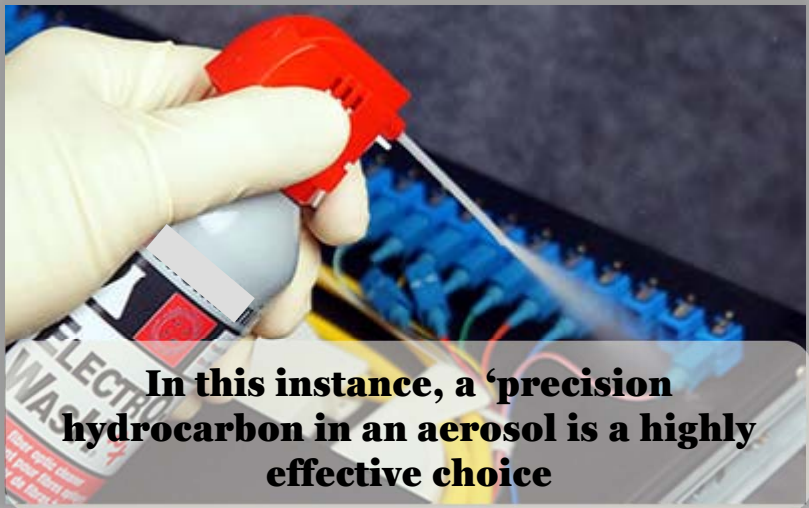
Step-2a SELECT THE RIGHT PRODUCT.
Compressed Gas Dusters with
“All-Way Valves” are far less likely
to emit freeze spray.

As well, the “blast” is >70psi so
less is used: you control the air
stream for effective drying.



Click to start

With Appreciation to Chemtronics@_



Step-3 Remove Residual Contamination such as sludge, pollen, and, other unknowns



The 3D nature of all sectors of every connector.



Step-3 may be trial and error.

However, the “right” precision hydrocarbon is an effective cleaner on the widest range of debris. It dries “fast enough”...but not so fast it’s wasteful.

With Appreciation to Chemtronics®_

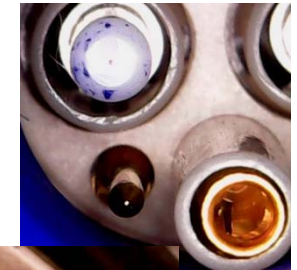
Step-4 Precision Clean and Precision Inspect all surfaces



Be Prepared for water or storm damage by practicing the procedures.

Have manufacturers train you. *Have the proper tools ready because in a time of need ... everyone needs.*

Plan and train.



With Appreciation to Chemtronics®_



THERE ARE THREE AREAS OF CONCERN:

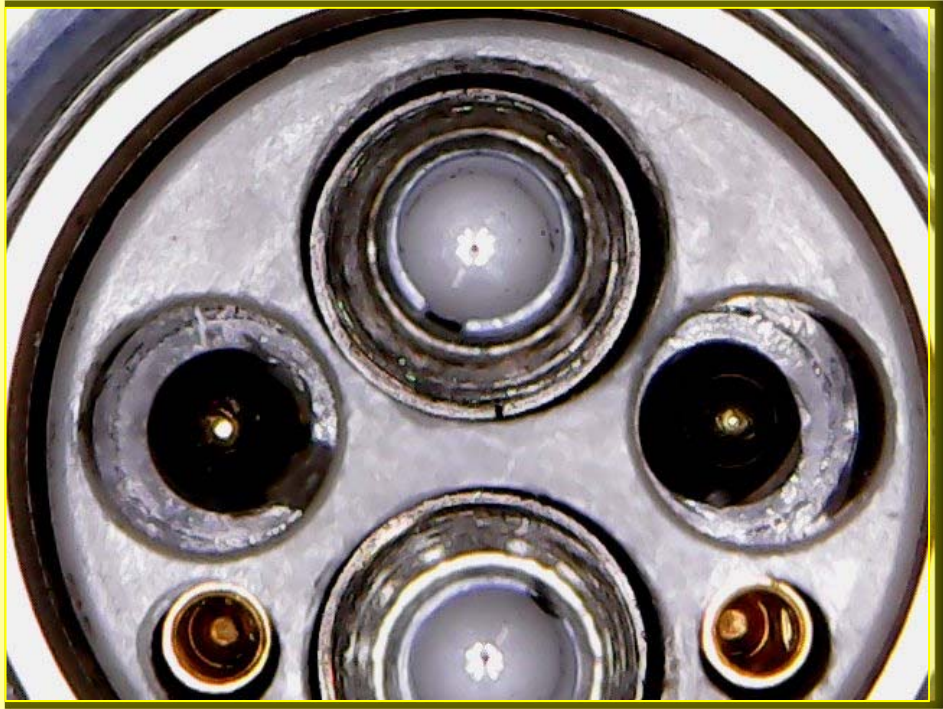
- 1.) the fiber conductor. 2.) copper surfaces and receivers, 3.) inter-surfaces.**

WHY IS IT CRITICAL TO CHARACTERIZE CONNECTORS IN THIS WAY?

The SIMPTE 304M connector is designed to transmit fiber and carry electrical current for HDTV broadcast applications.

This unique connector is a work horse with stainless steel shell and rugged positive fit characteristics. *This is knowledge beyond existing standards.*

- **Understanding the dynamics and interaction of the connector to type of contamination and location assures best practice and reliable transmissions. *This is knowledge beyond existing standards.***



Digital Photo Images captured on RMS-1© Video Microscope (Patent Pending)



1.) The fibers were cleaned prior to test sequence.



2.) Fiber was dyed. Note Zone-4 contamination extending to Zone-5



3.) SMPTE-Lemo fiber was properly cleaned



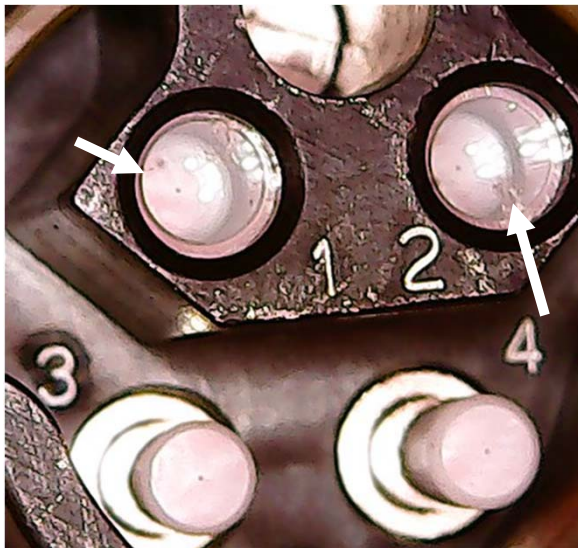
Zones 1-4: use a (lightly moistened)* tape-style probe tool w/extension adapter

A non-cotton swab tool* cleans Zone-5

The tool cleans to IEC 61300-3-35. Using additional cleaning devices may be necessary to assure transmission...or...*unnecessary replacement of a high value connector.*



DOD/Aerospace



Debris on Zone-5 and Zone-5

“The Connector & The Problem”

TFOCA-II, 38999, and other DOD/Aerospace connectors do not lead the ‘cushy life’ of their FTTx and DataCenter brethren.

As with all connector types, there is more than the “core”.

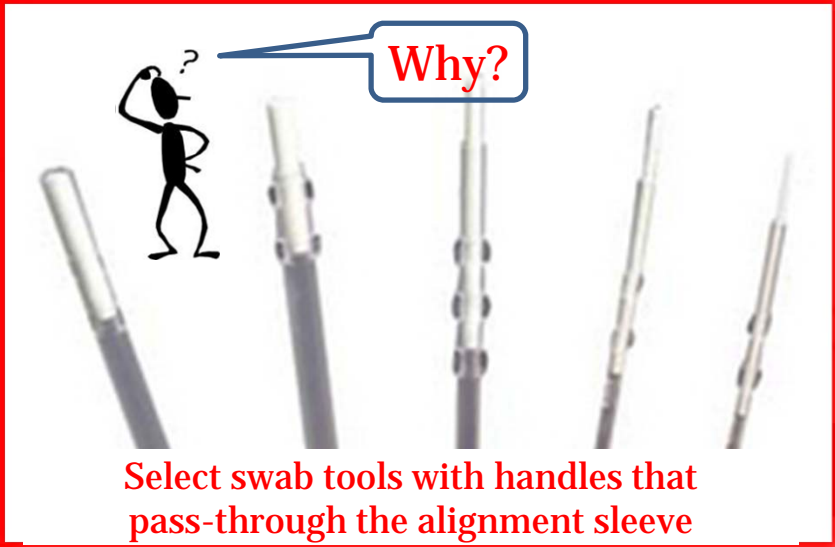
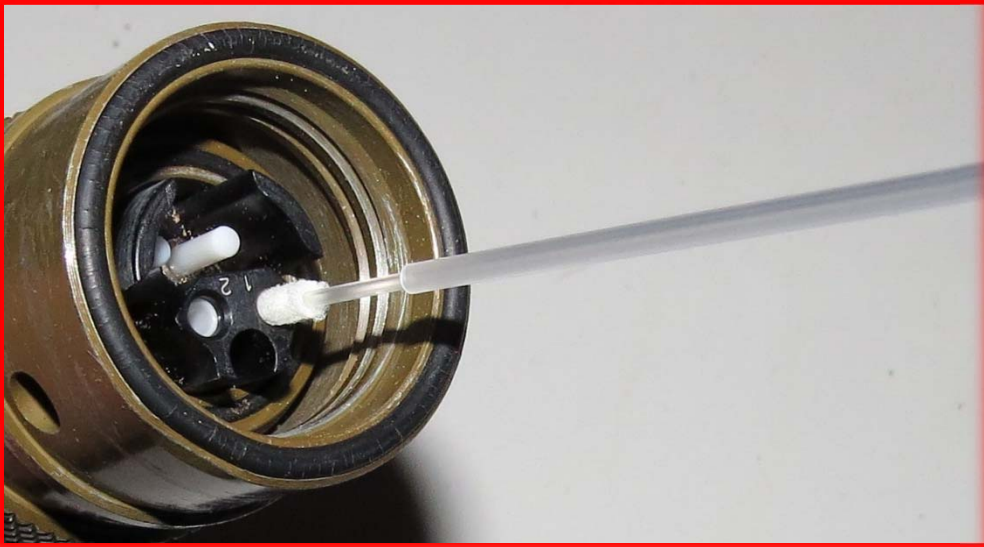
The arrows point to debris not seen by typical inspection. Digital photography or a loupe may be required.

Training when to use an instrument is a critical eye safety topic.



Digital Photo Images captured on RMS-1© Video Microscope (PatentPending)

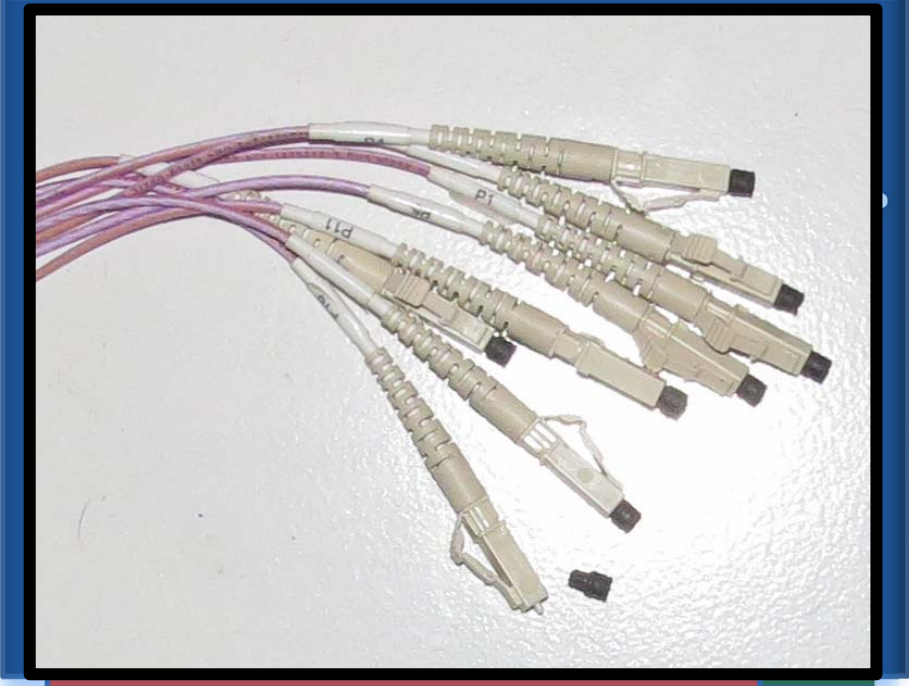
Swab tools work also. Be certain to select cleanroom grade foam which lightly compresses and conforms with the connector port.
Avoid “hard swab stick materials” that might reconfigure port geometry sizing.



Select swab tools with handles that pass-through the alignment sleeve



“Fiber Hygiene”: Controlling unforeseen influences on the condition of a fiber optic surface.



“Dust Caps”

Don’t assure cleanliness

Standards: “...do not assume a dust cap assures a clean end face.”

Protect against damage. Don’t try to clean the dust cap...clean the end face!

These are “future-proof/best-practices”.



Course Conclusions

THE “PROBLEMS WITH STANDARDS” EXIST IN ALL INDUSTRIES.

- The “time between” updates.
 - Commercial products based on standards
- “Problems’ are resolved when:**
- Designer, installer and trainers consider standards as “minimum requirements”.
 - Future proof: depend on groups like BICSI® . Independent researchers, subscribe to webinars, read White Papers...study.





“Good Science” considers the three-dimensional reality of the connector, debris, and, location.



Google® “bad science” to learn how it can be mistaken, misrepresented and accepted as “good science”.

There is another reality.

Copper, fiber optic, and copper/fiber hybrid connectors require inspection beyond existing standards.

Copper Connections are not going away without a technical fight!

Data Over Cable Service Interface Specification

(DOCSIS [/'dɒksɪs/](#)) is an international telecommunications standard that permits the addition of high-bandwidth data transfer (~1.4gig download) to an existing [cable TV](#) (CATV) system. It is employed by many cable television operators to provide Internet access over their existing [hybrid fiber-coaxial](#) (HFC) infrastructure. (Wikipedia)

Checking alignment on copper connectors assures continuity and extends life.

There are new cleaning techniques for “hybrid fiber/copper” surfaces in close proximity. Some copper connectors “fret” and/or “gall”. There are low-residue lubricant/protectants.

Use of a small amount of fiber optic grade precision cleaner on all tools...each time...drives the process closer to 1st time cleaning.

While 100% inspection is ideal ... a better cleaning process is a critical and practical advance.

The transmission fiber doesn't care about the deployment.

It "cares" about the debris that causes it to underperform...and how it's properly cleaned.

So the job is done right...The 1st Time.

**S
e
u**



Final Conclusion

**Remember: the 'transmission fiber'
is The Weakest Link.**

**If not properly cleaned (or spliced) it will
trickle-down signal loss on any
deployment ...
pure fiber optic or HFC.**

**Cleaning any fiber optic surface is
1 Mission Critical.**



Now you know!

When some one asks you 'how to clean a fiber optic connection'.

Do our Industry a big favor: pass it on!

Edward J. Forrest, Jr.
+770-971-8100 (USA)
edforrest@fiberopticprecisioncleaning.com
edwforrest@gmail.com (Private)
www.fiberopticprecisioncleaning.com



2019 BICSI Winter Conference & Exhibition

January 20-24 • Orlando, FL, USA

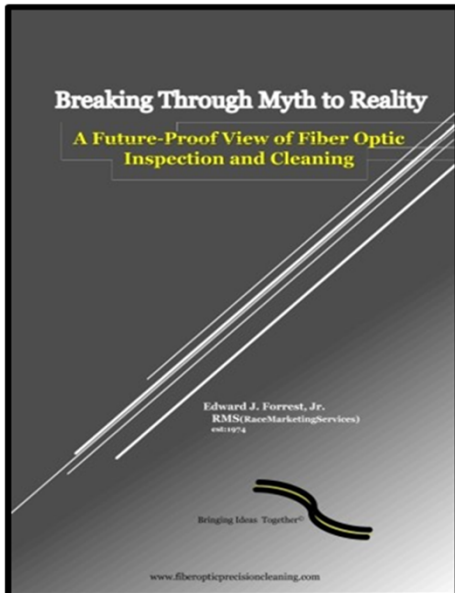


Fact OR FICTION
of
Fiber Optic Cleaning and Inspection

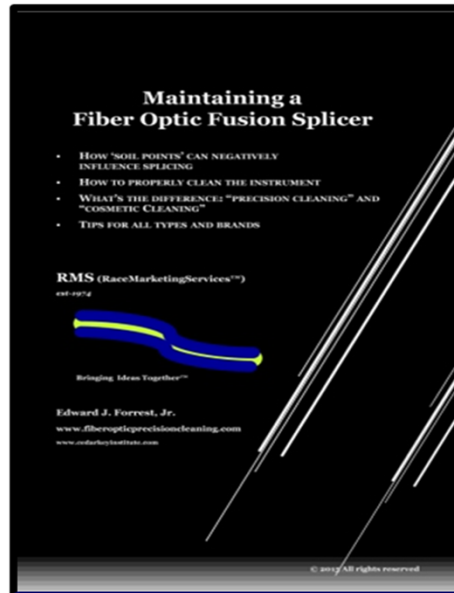


1. **F__ A Fiber Optic Connector is a Two-Dimensional Structure**
2. **F__ 99.9% “Reagent Grade” Isopropanol is an effective fiber optic end face cleaner**
3. **F__ Cleaning is not important... anything is better than nothing!**
4. **F__ There are OTHER WAYS BESIDES VIDEO INSPECTION to determine “clean”**
5. **F__ Debris on a fiber optic connector surface is two-dimensional “diameter”.**
6. **F__ Pass/Fail Automatic Detection is “good enough”**
7. **F__ Existing standards, such as IEC 61300-3-35, are “Best Practice”**
8. **F__ Use the same cleaning products for fusion splice as end face cleaning**
9. **F__ 5G Wireless does not depend on fiber optics**

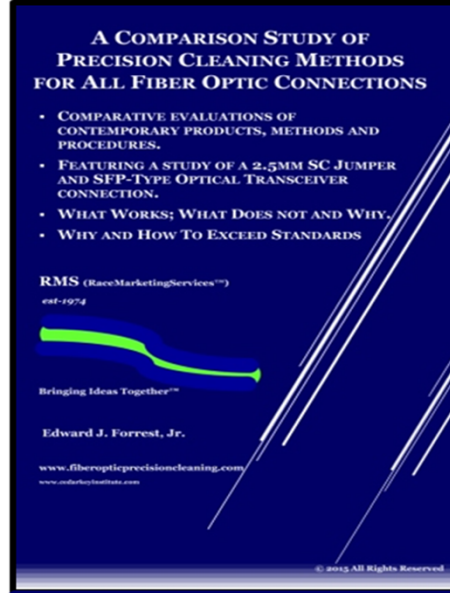




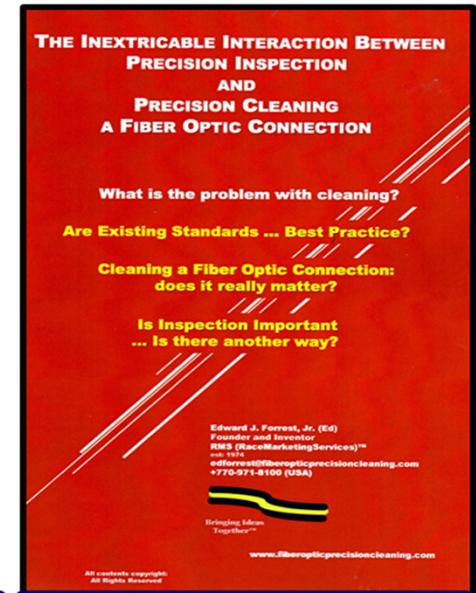
Companion Text Book to this course



Understand how to maintain a fusion splicer for lowest loss.



2014 Study updating "The Cisco® Series"



Short course on precision cleaning and inspection

**These books for additional Study available on:
 www.amazon.com (International)**

Please Inquire about quantity discounts for trainers, military and educational institutions.

