



The Fibreoptic Industry Association

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THE IMPACT OF CONTAMINATION (on "in-service connections")

by
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Anyone who considers the dimensions of optical fibre cores will realise the immediate potential impact of contamination on the end-faces of optical fibres that are to be mated within a connection.

Clearly contamination can reduce the transmission performance of the connection in terms of the total power transferred through it i.e. insertion loss. In addition, it should be realised that contamination may exist in three-dimensions (e.g. particulate debris) and such contamination may serve to create a gap between the two end-faces within the connection, then the return loss will deteriorate leading to unwanted reflections and "echoes" within the transmission system which may result in lost data at the receiver - directly impacting real time networks or slowing networks due to the need for re-transmission of that data.

The problems associated with high insertion losses are seen in both singlemode and multimode optical fibre systems. For multimode, the evolution of very high bit rate applications has been associated with significantly more stringent requirements for overall channel insertion loss. In singlemode operator networks, passive optical fibre networks employ similarly stringent insertion loss requirements and an increased use of connections, to support multiple access and service providers, places increased importance on return loss.

Of course, in the worst case, contamination can lead to permanent end-face damage which, in the case of the optical ports of transmission equipment can create a fault condition requiring replacement.

These operational errors may lead to extensive delays in the provisioning of services over the optical fibre and, in the worst case, an inability to offer a service.

Unfortunately, some users believe that periodic removal of contamination is all that is necessary to maintain system performance while others will not address contamination until a system actually fails. Such approaches are not recommended since they ignore the hidden impacts of contamination.

This White Paper discusses the nature of contamination and its impacts.

Other White Papers in this series cover "Camera-based inspection" and "Cleaning" while ShortForm Guidance Notes provide information on how these processes apply during procurement, installation, operation and troubleshooting.

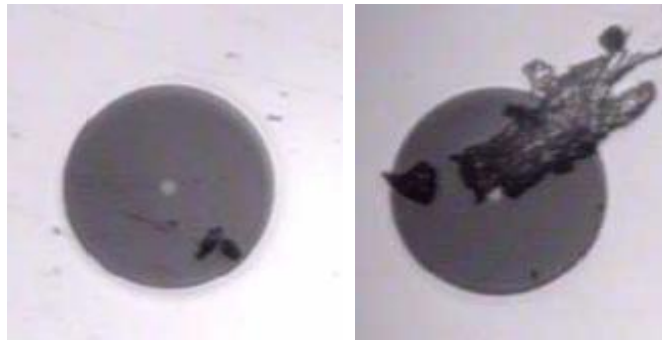
Sources of contamination

Mishandling of a plug end-face is the most common source of contamination. Examples of such solutions include:

- touching the end-face which may spread skin oil or other materials on the skin over the end-face;
- allowing plug end-face on clothing can introduce liquids (including oils) previously absorbed by the fabric, lint generated from the material, particles held in the fabric or surfactants from previous cleaning of the garment;
- leaving a port or plug end-face unprotected from the environment subjects the end-face to environmental sources of contamination.

Environmental sources of contamination include:

- building materials, such as sawdust, sheet plaster dust and paint fumes, are a common contributor to contamination;
- pollutants in the air;
- airborne dust particles (which in damp humid areas condense on the plug end-faces and alignment sleeve;
- condensation residues.



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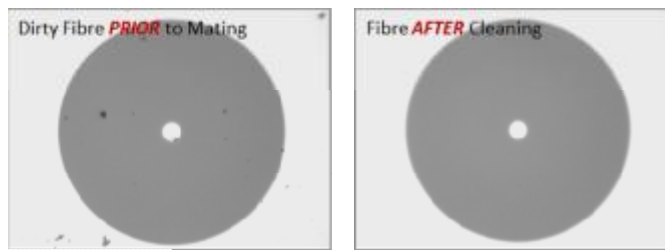
There are many **FALSE** operational assumptions that lead to underperforming or failing infrastructures or links.

To be clear, it **CANNOT BE ASSUMED** that:

- a) installation acceptance testing has left the connections in a “clean” condition;
- b) protective caps on plugs or adaptors provide a barrier against dust and basic contamination (although they may be useful preventing bulk contamination and physical damage to optical fibre end-faces);
- c) cords for both testing or operational connections are in a “clean” condition (even as purchased, “straight out of the bag”)
- d) transmission card optics (SFP/XFP/CFP) are in a clean condition (even as purchased, “straight out of the box”).

The hidden impact of contamination

As shown in Figure 1, cleaning before mating produces a contamination- and defect-free optical fibre end-face.



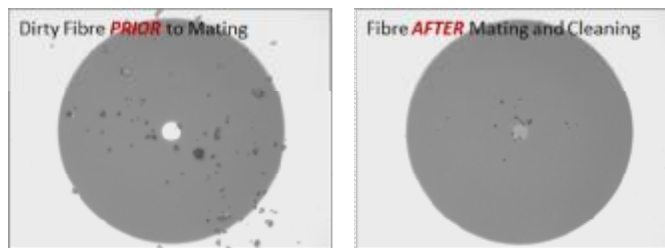
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Figure 1 - Typical result of cleaning before mating

It is tempting to think of contamination as simply having an effect on the transmission performance of a mated connection. However, this ignores two vitally important aspects of the impact of contamination.

The first is that in today’s connection the pressure applied between the two plugs in a sprung connection system is extremely high and certain types of contamination can become embedded in the optical fibre regions of the two plugs. This is illustrated in Figure 2 and shows permanent defects that cannot be removed by cleaning.

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Figure 2 - Typical result of not cleaning before mating

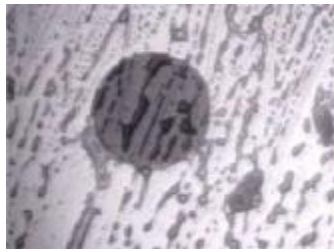
This can result in permanent damage to the optical fibre end-faces which cannot be remedied by cleaning. Such damage may also result in FAIL assessment of end-face condition if assessed against the requirements of BS EN 61300-3-35.

The second hidden impact is that contamination travels between plugs, as illustrated in the images in Figure 3. The insertion of a contaminated plug into a port will spread that contamination to the mated end-face, which in turn will spread the contamination to the next plug that is plugged into the port. Below are pictures of the results of mating a clean plug with a contaminated plug.

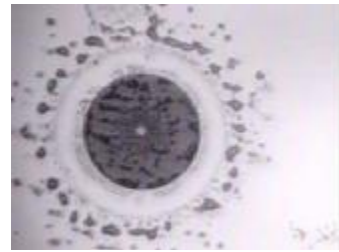
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Plug A before mating to Plug B



Plug B before mating to Plug A



Plug A after mating to Plug B

Figure 3 - Contaminant spread

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101 This is a common problem when test cords are not subjected to rigorous controls - leading to widespread
102 contamination and both errors of test results and a risk of damage to installed cabling terminations.

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104 Both these impacts are the basis of the FIA recommendations in relation to the "Inspect-Clean (if necessary) - Re-
105 inspect - Connect" philosophy which is stated in the other White Papers and ShortForm Guidance Notes in this
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