



International Electronics Manufacturing Initiative

**Fiber Connector End-
Face Inspection
Specifications**

*Face-to-Face Meeting
OFC 2005, Anaheim
March 7, 2005*

- **Introduction** 9.00 a.m.-9.15 a.m.
- **Statement of Work** 9.15 a.m.-9.30 a.m.
(Dr. T. Berdinskikh, Celestica)
- **Development of Cleanliness**
Specification for SM connectors 9.30 a.m.-10.00 a.m.
(Dr. T. Berdinskikh, Celestica)
- **DOE for the Receptacle Modules** 10.00 a.m.-11.00 a.m.
(Mr. Yutaka Sadohara, Sumitomo Electric)
- **DEO for the MM Fiber** 11.00 a.m.-12.00p.m
(Mr. S. Lytle, Westover Scientific)

- . Currently there is no industry standard for fiber optic end-face cleanliness**
- . This impacts the cost of manufacturing products that use fiber optics. End-customers are not in agreement with suppliers on the level of cleanliness required for fiber optic end-faces**
 - Connector cleanliness has a significant impact on in-process yield and cause of returns**
 - There was a lack of scientific backing for many of the standards used by companies in the industry**
 - The research performed by the iNEMI Optical Signal Performance Project is being used as a basis for the draft IPC cleanliness standard. It has also been reviewed by the IEC and TIA committees that are developing their own respective standards.**

- **Objectives**

- **The Fiber Connector End-Face Inspection Project is a follow-on initiative to the iNEMI Fiber Optics Signal Performance Project.**
- **The project will develop visual inspection criteria for polished for singlemode and multimode fibers as well as receptacle-type connectors. Requirements for allowable surface defects such as scratches, pits, and contamination will be identified.**
- **Based on experimental data and mathematical modeling, zone criteria and pass/fail visual requirements will be defined. The criteria will focus on singlemode and multimode polished connectors as well as receptacle-type connectors.**
- **Specifications for dust cap cleanliness including requirements for the mechanical design, material type, and test methods, will also be developed.**
- **This project will collaborate with the International Electrotechnical Committee (IEC), Telecommunications Industry Association (TIA) and IPC to develop a cleanliness standard. The project will also focus on improving the cleaning process and prevention of fiber endface contamination**

- **Background**

- **The Fiber Optic Signal Performance Project investigated the influence of scratches, particles and oil contamination on insertion loss (IL) and return loss (RL) of single-mode SC connectors.**
- **It was found that:**
 - **Scratches (2um or less), within MFD, have no impact on IL but can degrade RL.**
 - **Polishing scratches outside the fiber MFD have no impact on IL or RL.**
 - **Application of oil contamination results in significant degradation of RL (10-12 dB) and does not result in any significant changes of IL.**
 - **The contamination of the core zone, which has a diameter of 25 um from the core, with Arizona Road dust increased IL (changes up to 1.8 dB).**
 - **The contamination of the core zone combined with the presence of clusters of particles with a diameter of >30um in the cladding layer may result in catastrophic changes of the RL (changes of 10-40 dB).**
 - **Arizona road dust particles on the cladding layer (outside of the 25 um core zone) and ferrule do not significantly impact performance.**
 - **Contamination particles can prevent direct physical contact, creating an air gap between two endfaces.**

- **Project results were reported at the OMI conference (2003), IEC meeting (Montreal, 2003), APEX 2004, IEC meeting (Locarno, 2004) and IEC meeting (Warsaw, 2004). Five papers have been published based on project research including the paper published by APEX 2005.**

- **Fiber Optic Connector End-face Anomaly Assessment for SM fiber**
 - **The losses, (IL and RL), which occur on ST, FC, LC, MU, APC connectors due to contamination with Arizona Road Dust and polishing scratches will be examined.**
 - **The DOE (Design of experiment) that was used in the Fiber Optic Signal Performance Project for singlemode SC connectors will be used for this phase of the project. (Ref: Avanex experiments, Optical Signal Performance project)**
 - **Statistical data analysis will be performed.**
 - **Results for the influence of scratches and Arizona road dust for SC connectors will be compared with the results from the other types of connectors (ST, FC, LC, MU)**
 - **Mathematical modeling for the RL results will be provided.**
 - **Inspection criteria for SM connectors will be developed**

- **Fiber Optic Connector End-face Anomaly Assessment for MM fiber**
 - The loss (IL, RL, and BERT) realized by MM applications due to fiber optic connector end-face anomalies (polishing scratches and Arizona dust contamination) will be assessed.
 - The DOE (Design of experiment) that was used in the Fiber Optic Signal Performance Project for singlemode SC connectors will be used for this phase of the project. (Ref: Avanex experiments, Optical Signal Performance project)
 - Statistical data analysis will be performed.
 - Inspection criteria for MM connectors will be developed

- **Fiber Optic Connector End-face Anomaly Assessment for Receptacle Modules**
 - The different technologies for the receptacle modules to be studied will be identified (fiber stub, lenses, contact, non-contact, etc.)
 - Data rates to be studied will be chosen (OC-48, OC-192, etc.)
 - Critical parameters sensitive to scratches and/or contamination will be identified
 - The DOE will be performed (based on Sumitomo/ExceLight initiatives)
 - Relevant types of anomalies will be identified (e.g. Arizona road dust, typical work-bench surface contamination (dust), scratches, pits)
 - A method for application of anomalies will be developed
 - The influence of the Arizona road dust and scratches on the optical performance of receptacle modules will be investigated
 - Statistical data analysis will be performed (Minitab software can be used for this)
 - Critical factors such as particle size, distance from the core, type of particles, will be identified
 - The correlation between measurements, (RL, BERT and other tests yet to be determined), and images of the connector end-face will be investigated.
 - Criteria for cleanliness of receptacle modules will be developed

- **Collaboration with standards bodies**
 - **A roadmap for the collaboration with the TIA, IPC, IEC will be developed.**
 - **Collaboration with the IPC will be on standard IPC-8794-01: "Cleaning methods and contamination assessment for optical assembly."**
 - **A recommendation to update the IEC doc "61300-3-35: Basic test and measurement procedures" based on quantitative data will be put forth.**
 - **Recommendations will be harmonized across all vendors, EMS providers, and OEMs to achieve a true international standard.**

- **Improving the cleaning process and prevention of contamination**
 - **To understand the root causes of contamination and develop the strategy to prevent or minimize the risk of contamination in the manufacturing environment**
 - **Compare different cleaning materials with improved ESD capability to prevent connector charging during the cleaning process**
 - **Contamination caused by the dust cap**
 - **Standardization of the dust cap: developing a recommendation on materials and design**

- **Project Expected Results**
 - **Identify the effects of contamination / scratches etc. on fiber optic signal performance with quantitative evidence for SM, MM fiber and receptacle modules**
 - **Collaboration with IPC on standard IPC-8794-01: "Cleaning methods and contamination assessment for optical assembly."**
 - **Update the criteria in IEC doc "61300-3-35: Basic test and measurement procedures" based on quantitative data.**
 - **Development of a fiber connector endface inspection criteria specification for receptacle devices**
 - **Identify recommended cleaning procedures and contamination prevention guidelines**

- **The Fiber Connector End-Face Inspection Specifications Project will be open to non-members of NEMI. Potential participants include, but are not limited to, OEM(outside equipment manufacturers), EMS providers, previous members of the NEMI Fiber Optic Signal Performance Project, suppliers of fiber optic cables and receptacle modules, inspection equipment suppliers and fiber optic connector cleaning solution suppliers.**

- **Tatiana Berdinskikh, Celestica, Project Chair**
- **Steve Lytle, Westover Scientific**
- **Randy Manning, Tyco Electronics**
- **Tom Mitcheltree, Cisco Systems**
- **Thomas Ronan, Aerotech**
- **Heather Tkalec, Alcatel, Project Co-Chair**
- **Frank (Yi) Zhang, Avanex**
- **Jose Garcia, Doug Kedrosky, JDS Uniphase**
- **Henry Genchanok, Molex members (add)**
- **Scott Takahashi, Sumitomo Electric**
- **Carla Gleason, Sumitomo Electric/ExceLight**
- **Yutaka Sadohara, Sumitomo Electric**
- **Daniel A. Kruschwitz, Lucent Technologies**
- **Matt Brown, USCONEC**
- **Phillip Hayashida, Intel**
- **Pi Su, Dicon Fiberoptics**
- **Sharon Huang, Kevin Shirk, Light Tech**
- **Dan Frederick, Tom Edwards, Agilent**
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