



AEROSPACE INFORMATION REPORT

AIR6031™

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Fiber Optic Cleaning

RATIONALE

Cleaning is crucial to achieve and maintain the best possible operation of any optical fiber based application. Far too many failures are caused by poor or improper cleaning. Contamination of contact endfaces can lead to decreased system performance and damage to the optical fiber or ferrule.

AIR6031 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

This document is intended for connectors typically found on aerospace platforms and ground support equipment. The document provides the reasons for proper fiber optic cleaning, an in-depth discussion of available cleaning methods, materials, packaging, safety, and environmental concerns. Applicable personnel include:

Managers
Designers
Engineers
Technicians
Trainers/Instructors
Third Party Maintenance Agencies
Quality Personnel
Purchasing
Shipping/Receiving
Production

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI Z136.1-2007 American National Standard for Safe Use of Lasers

ANSI Z136.2-1997 American National Standard for the Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources

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Full document details: SAE AIR6031

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Documents

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2.2 IEC Publications

Available from International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland, Tel: +44-22-919-02-11, www.iec.ch.

IEC 60825-1 Laser Safety Equipment Classification (Safety of laser products)

IEC 60825-2 Safety of Optical Fibre Communication Systems

IEC 60825-4 Laser Guards

3. SAFETY

It is the responsibility of every employer to preserve, so far as is reasonably practicable, the health, safety and welfare of all employees. Common hazards often include chemical, optical power, fiber fragments, environmental, explosive, and personnel.

Employers should ensure material safety data sheets (MSDS), first aid kits and eye wash stations are available in all areas where fiber optic work is being conducted. Fume hoods should be utilized where applicable.

General awareness of working around aircraft and other potentially explosive environments is a consideration when utilizing any arc fusion splicers, curing ovens, ultrasonic cleaners or other electrical or electronic devices.

In addition, all employees have a duty of care to their work colleagues. It is the responsibility of every employee while at work to take reasonable care for his/her own health and safety and of other persons who may be affected by his acts or omissions at work with regard to:

3.1 Handling

Care should be taken when handling fibers. Flying glass fragments are often the result of cutting and cleaving operations and often go unnoticed. Glass fibers are small enough to puncture the skin and can remain under the skin surface. Besides being an irritant, fragments of glass fibers are not easily seen and can be difficult to remove. It is particularly important to prevent stray fragments from entering the eyes where removal is even more difficult. Clear lenses can deflect a stray fiber end and can prevent it from piercing the eyeball or prevent minute fragments from entering the eye. Safety glasses and protective clothing must be worn when working with fibers. Further information on eye safety precautions can be found in References 2.1 and 2.2 to this document.

Eating and drinking in the vicinity of fibers increases the risk of accidental ingestion of glass fibers. All eating and drinking must not be permitted. In addition, fiber fragments can adhere to skin oils, so after working with fibers, individuals must ensure their hands are thoroughly washed prior to coming into contact with the face or eyes.

During installation and repair, all snipped or cleaved pieces of optical glass fibers must be placed in appropriate dedicated disposal containers. Placing fibers on an adhesive tape strip can be dangerous and must not be encouraged. Fiber waste must never be placed in ordinary garbage for routine disposal. Cables with exposed fiber ends must be adequately protected or positioned to preclude accidental skin puncture or eye damage. The most effective defense against fiber-related injury is common sense.

Unmated connectors and fibers may transmit non-visible radiation and direct viewing with the eye must be avoided at all times. Active fiber optic systems are not to be inspected with optical magnifying scopes. Protective end caps and connector covers must always be utilized on all unmated connectors.

3.2 Optical Power Source

Although the optical power level in installations can be relatively low, the minute dimensions of fiber cores and semiconductor sources makes it possible for intensities to attain surprisingly high values. If an optical cable is disconnected or broken and the exposed end is examined, there is a risk of eye damage. This risk can be exacerbated if a magnifier or other visual aid is used.

It should always be assumed that a system is switched on until test equipment can verify the status of optical sources. Moreover, in applications that require higher intensity optical sources, system designers must include additional safety precautions to ensure the safety of maintenance personnel.

3.3 Lasers and Light Emitting Diodes (LED)

Lasers commonly used as fiber sources operate at wavelengths of 850, 1300, and 1550 nm, which are all in the infrared part of the light spectrum. Lasers differ from LEDs in the fact that they are coherent, collimated, low divergence and have small spot sizes. The 850 and 1300 wavelengths, along with visible light, are focused by the eye onto the retina. Retinal receptors are particularly sensitive to the 400 to 700 nm wavelength range, but not to wavelengths outside the range; herein lies the danger. The laser will continue to focus on the sensitive retinal tissue even though the individual is unable to perceive the intense light from the laser. At the focal point, energy density can be high enough to burn the tissue, resulting in blind spots in the individual's visual field or loss of visual activity. This may still occur even though lasers involved with fiber use are actually of low power compared to other laser types.

The class of an individual laser depends on its operating wavelength, its output power, and whether it is pulse or continuous wave. The concentration on low power infrared lasers is sufficient for fiber optic theory. Lasers/LEDs are classified into four general categories:

3.3.1 Class 1

Considered "eye-safe" to the unaided eye and that no eye damage will result even from prolonged exposure to the direct beam. As the retina more heavily absorbs shorter wavelength light, especially at wavelengths below 550 nm, the maximum output power of Class 1 lasers generally increases with increasing wavelengths. As laser emissions at wavelengths greater than 1400 nm are absorbed by the cornea, no focusing onto the retina occurs and the Class 1 laser maximum output power increases dramatically.

3.3.2 Class 2

Those for which this aversion response will protect an individual from the output. Class 2 lasers include only those emitting visible radiation and many fiber identifiers fall into this category. No Class 2 lasers are used in fiber systems.

3.3.3 Class 3

Possess medium power and produces radiation that can cause eye damage when viewed directly, or when a magnified reflection is viewed. A diffuse reflection is not usually a hazard. Two subcategories are defined as Class 3A and Class 3B.

3.3.4 Class 4

High power and not used in communication/data cable plant applications. Most lasers used with fiber communications systems are well below the energy levels that would cause skin burns, but the risk of eyesight damage is very real. The danger is highest at optical outputs where energy emerges directly from the laser.

3.4 Eye Safety

Wearing safety glasses to protect your eyes from accidental injury is strongly recommended when handling chemicals, cutting fiber, or, fast moving gas. Pieces of glass fiber are very sharp and can damage the cornea of the eye.

3.5 Hazardous Materials

All MSDS information should be made available, and appropriate safety and handling procedures used when working with chemicals and other hazardous materials.

3.6 Foreign Object Damage (FOD)

Fiber optic installation and maintenance will produce large quantities of debris, including packaging, wipes, fibers, and swabs which can lead to FOD. It is essential that all work areas are thoroughly policed and cleaned throughout the process.

4. CONTAMINATION, CAUSES AND EFFECTS

Correct cleaning procedures must be followed to maximize system performance and reliability.

4.1 The Sources of Contamination

There are many sources of contamination in the harsh aerospace environment. However, other less harsh environments such as the production floor have many sources of contamination too. Contamination can take various forms, be in combinations, and be delivered with different mechanisms.

4.1.1 The Environment

The environment is a natural source of contaminants with a variety of delivery mechanisms. An interconnection exposed to the environment for a brief period of time can be contaminated by particulates such as pollen, dust, sand, salt, or chemicals alone or in combination. Examples of endfaces contaminated by the environment are shown in Figures 1 through 8.

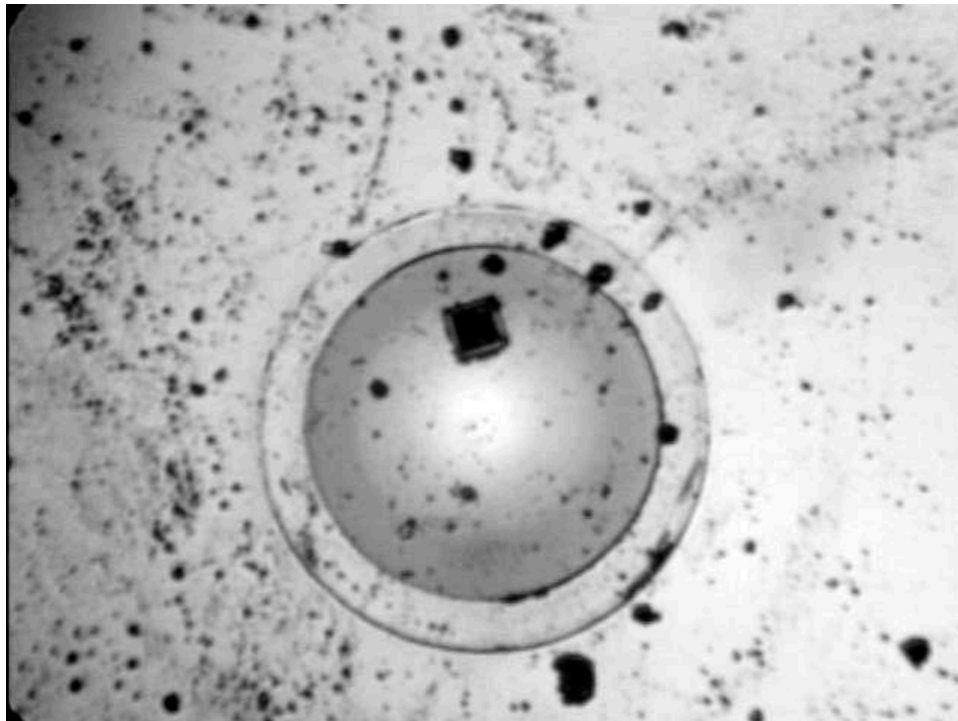


FIGURE 1 - ENDFACE CONTAMINATED WITH DRY SALT WATER DEPOSITS

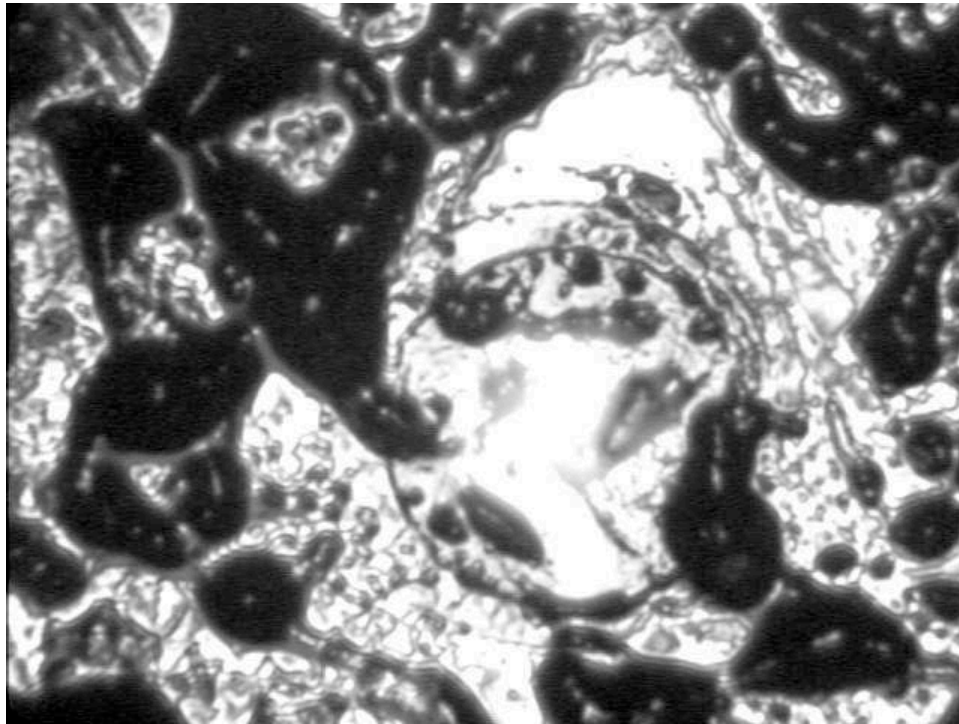


FIGURE 2 - ENDFACE CONTAMINATED WITH INSTRUMENT GREASE

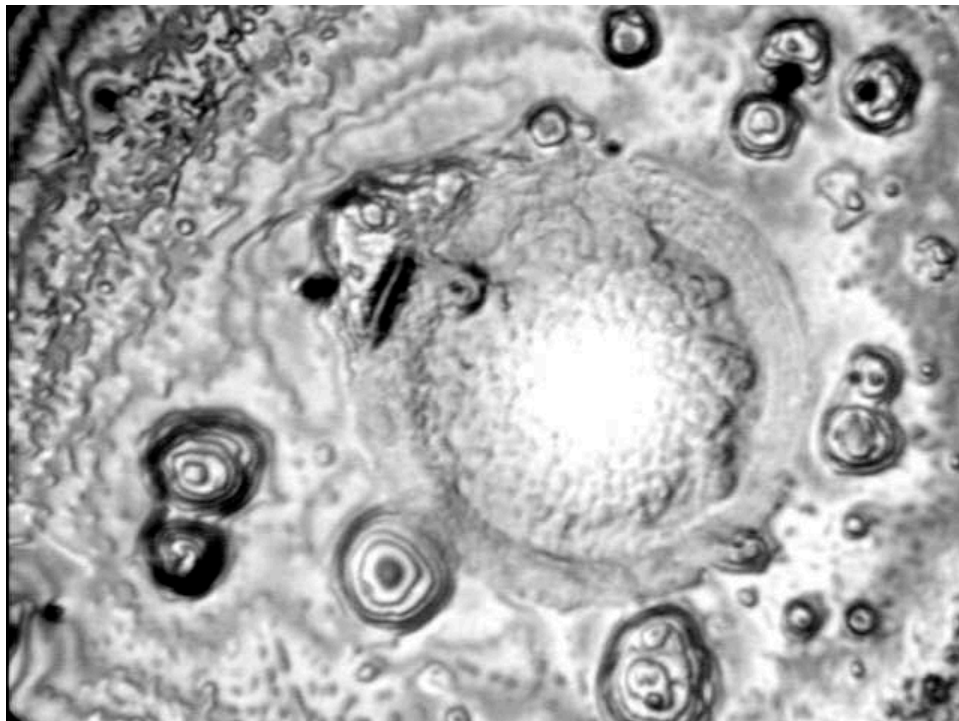


FIGURE 3 - ENDFACE CONTAMINATED WITH CLEANING COMPOUND

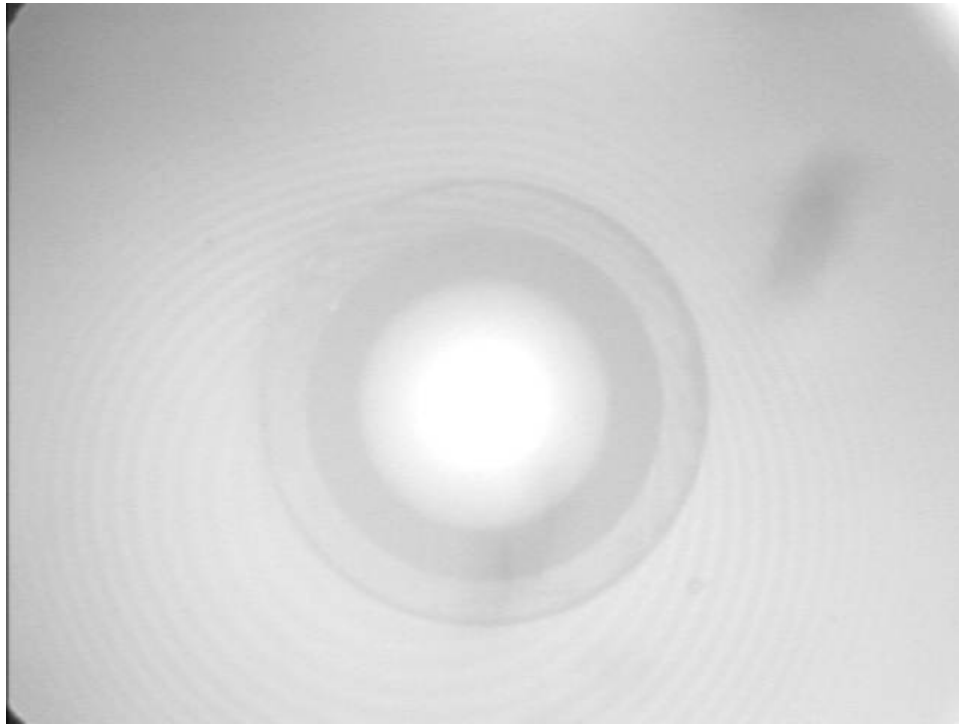


FIGURE 4 - ENDFACE CONTAMINATED WITH SYNTHETIC HYDRAULIC OIL

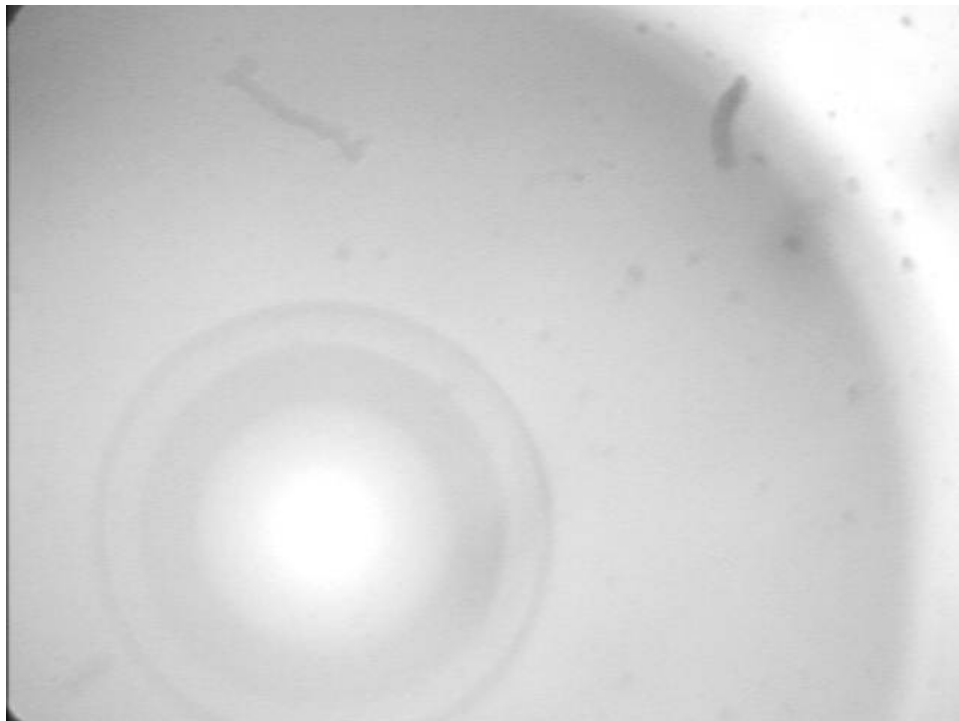


FIGURE 5 - ENDFACE CONTAMINATED WITH USED HYDRAULIC OIL