IPC-WP-114A

Guidance for the Development and Implementation of a White Plague Control Plan (WPCP)

Developed by the Wire Harness Design Task Group (7-31k)
of the Product Assurance Committee (7-30) of IPC

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Users of this publication are encouraged to participate in the development of future revisions.

Contact:
IPC

Tel 847 615.7100
Fax 847 615.7105

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TECHNICAL BACKGROUND

During the manufacturing of fluoropolymer-insulated electrical wires and cables made with tin-coated, silver-coated, or nickel-coated conductors of copper or copper alloy, the extrusion of fluorocarbon resin occurs at a temperature high enough that oxidative degradation of the polymer will occur, resulting in the evolution or outgassing of a number of materials, including carbonyl fluoride (COF_2), an extremely reactive compound. This outgassing from the insulation jacket is both internal (to the wire strand/cable bundle) and external (to the surrounding environment).

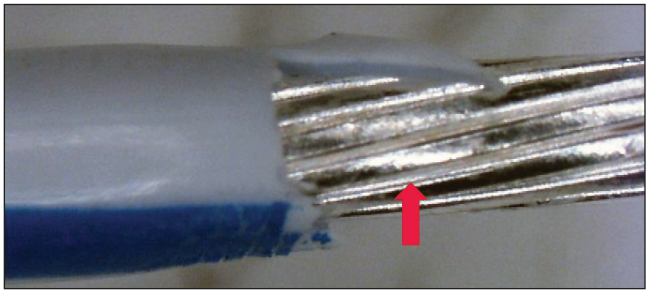

Figure 1-1 White Plague (Fluorine Attack)
Note white frosted section on silver **coating**
(Photo Courtesy of NASA)

Chemical Reaction – In the presence of trace atmospheric moisture (e.g., humidity), the carbonyl-difluoride hydrolyzes to generate carbon dioxide (CO_2) and hydrogen fluoride (HF). The hydrogen fluoride (HF) will then hydrate to form concentrated hydrofluoric acid (HF aq), which is a corrosive agent that reacts with metal and metal oxides.

Scavenger/Dopant – Antimony oxide (Sb_2O_3) is known for its ability to scavenge the decomposed HF, preventing wires from the corrosive attack by the decomposed HF, and wire manufacturers heavily dope the fluoropolymer insulation with antimony oxide to reduce the amount of outgassing. However, while the amount of antimony oxide in the insulation might be able to reduce the amount of outgassing and the resultant corrosion in the short term, outgassing and corrosion would eventually occur after the antimony oxide's scavenging capacity is exhausted/overwhelmed.

ETFE (Tefzel™) – While fluorine outgassing is a concern for all fluoropolymer insulations, ethylene tetrafluoroethylene (ETFE) and cross-linked ethylene tetrafluoroethylene (XL-ETFE) have been reported to have a higher evolution rate, possibly due to the blending and extrusion processes typically used for this polymer.

1 GENERAL REQUIREMENTS

1.1 Scope This document introduces design concepts, guidelines, procedures, practices, process attributes, and recommendations for the control and mitigation of performance and reliability risks associated with the use of fluoropolymer-insulated wire and cable in the manufacture of electrical and electronic assemblies, including optical and metallic cable and wiring harness assemblies, and elements thereof.

1.2 Purpose The intent of this document is to provide guidelines and a template for the development and implementation of a White Plague Control Plan (WPCP).

For purposes of this document:

- The Designer is the design agent for the User.
- The User is the individual, organization, company, contractually designated authority, or agency responsible for the procurement or design of electrical / electronic / electromechanical (EEE) hardware and having the authority to define the class of equipment and any variation or restrictions to the requirements of this document (e.g., the originator / custodian of the contract detailing these requirements). The User is considered the Design Authority.
- The Supplier is considered the individual, organization, or company which provides the Manufacturer (assembler) components (e.g., electrical, electronic, electromechanical, mechanical, printed boards, etc.), and/or materials (e.g., solder, flux, cleaning agents, etc.).
- The Manufacturer is considered the entity that provides a service or product to the User.

1.3 Applicability This document is targeted for applications where exposure to assembly processes, environmental conditions, and contamination may promote the development of fluorine attack (White Plague) in fluoropolymer-insulated wire, cable, and harness assemblies. The requirements of this document apply to all organizations involved in the design, manufacture, and installation of fluoropolymer- insulated, silver-coated copper wire, cable, and harness assemblies.

a. The design concepts, guidelines, and procedures presented in this document are for guidance ONLY, and **are not** requirements. As such, the use of the words ''**must**,'' ''**should**'' and ''**shall**'' (and derivations thereof) have no special meaning in this document, and they do not indicate a binding criterion.
b. This document is **not** binding, unless separately and specifically included by the applicable contract, approved drawing(s), or purchase order.

1.4 Commercial Off-The-Shelf (COTS) This document does not apply to the manufacture of Commercial-Off-The-Shelf (COTS) or catalog items (e.g., components, assemblies, subassemblies and/or hardware). Designers considering the use of COTS hardware for applications described above are responsible for identifying and managing risks associated with hardware built without a control plan to reduce the harmful effects of fluorine attack (White Plague) in electrical and electronic (E/E) assemblies, including optical and metallic cable and wiring harness assemblies, and elements thereof.

1.5 Existing or Previously Approved Designs The implementation of a White Plague Control Plan (WPCP) **should not** constitute the sole cause for the redesign of previously approved designs. When drawings for existing or previously approved designs undergo revision, they **should** be reviewed and changes made that allow for compliance with the requirements of the imposed Plan.

1.6 Measurement Units and Tolerances All dimensions and tolerances, as well as other forms of measurement in this standard are expressed in SI (System International) units, with Imperial English equivalent dimensions provided in [brackets], except as noted.

a. Linear dimensions and tolerances use centimeters (cm) [inches (in)] as the main form of dimensional expression; millimeters (mm) [inches (in)] or micrometers (µm) [microinches (µin)] are used when the required precision makes the use of centimeters (cm) too cumbersome.
b. Temperature values are expressed in degrees Celsius (°C) [Fahrenheit (°F)].
c. Mass is expressed in grams (g) [ounces (oz)].
d. Wire, wire harness, and cable diameters are expressed in the non-dimensional unit (d), where a numerical dimension, such as 2d, is solely dependent on a physical attribute of the hardware (e.g., wire gauge, harness diameter, etc.).
e. Time values are expressed in hours, minutes and seconds (hh:mm:ss).
f. Absolute Dimensions. For the purposes of determining conformance to this specification, all specified dimensions and/or tolerances in this standard are "absolute limits" as defined in ASTM E29 [5.1]. Actual measurement of specific dimensions and determination of percentages is not required, except for referee purposes, or as specified otherwise by engineering documentation.

Note: *This Standard uses other SI prefixes (ASTM SI10, Section 3.2), as applicable, to eliminate leading zeroes (for example, 0.0012 mm becomes 1.2 µm) or as alternative to powers-of-ten (3.6 x 103 mm becomes 3.6 m).*

1.7 Terms and Definitions Terms and definitions are consistent with those listed in IPC-T-50. For the understanding of this document, selected terms and definitions are listed in Section 5.

2 APPLICABLE DOCUMENTS

The following documents are applicable to the extent specified herein. Unless otherwise specified, the issue/revision identified herein, or the issue/revision in effect on the date of invitation for bid, or request for proposal, will be applicable.

2.1 Federal Standards

27 CFR 21.35 Code of Federal Regulations, Title 27, Part 21, Sub-part 35, Formula No. 3-B

O-M-232 Federal Specification, Methyl Alcohol

TT-I-735 Federal Specification, Isopropyl Alcohol

2.2 Military Standards

MIL-D-3464 Desiccants, Activated, Bagged, Packaging, Use and Static Dehumidification (Type II)

MIL-PRF-81705 Barrier Materials, Flexible, Electrostatic-Free. Heat Sealable (Type I)

MIL-STF-2073-1 Standard Practice for Military Packaging (Method 50)