IPC-WP-114

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

Developed by the Wire Harness Design Task Group (7-31k) and IPC-HDBK-620 Handbook Task Group (7-31h) of the Product Assurance Committee (7-30) of IPC

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

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TECHNICAL BACKGROUND (Figure 1-1)

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).

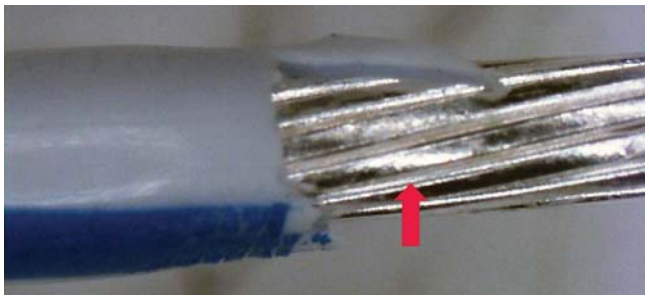

Figure 1-1 White Plague (Fluorine Attack)
Note white frosted section on silver coating
Photo credit: NASA

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/over-whelmed.

ETFE (TefzelTM) – 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 (i.e., 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 (electrical, electronic, electromechanical, mechanical, printed boards, etc.) and/or materials (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,