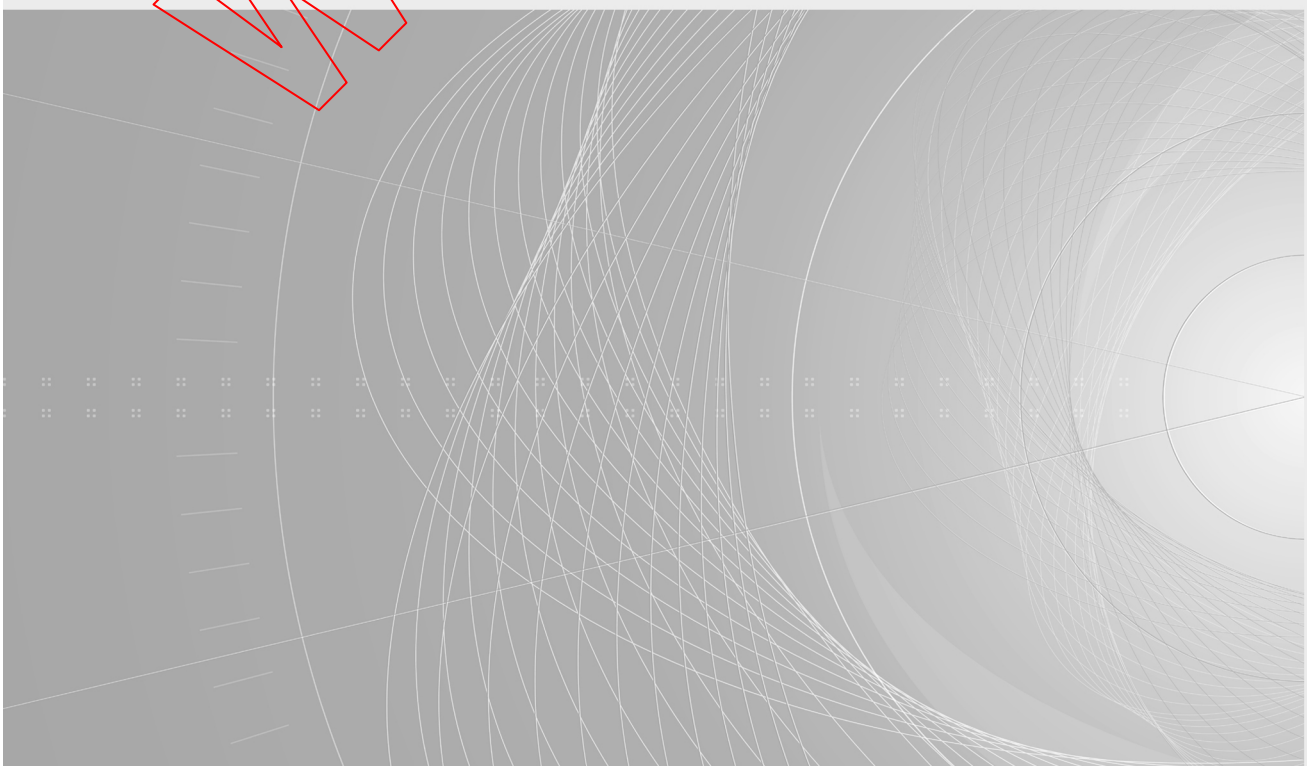
IEC/PAS 62647-2

Edition 1.0 2011-06

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

Process management for avionics – Aerospace and defence electronic systems containing lead-free solder –
Part 2: Mitigation of the deleterious effects of tin



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Process management for avionics – Aerospace and defence electronic systems containing lead-free solder –
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROCESS MANAGEMENT FOR AVIONICS – AEROSPACE AND DEFENCE ELECTRONIC SYSTEMS CONTAINING LEAD-FREE SOLDER –

Part 2: Mitigation of the deleterious effects of tin

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A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62647-2 has been processed by IEC technical committee 107: Process management for avionics.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
107/108/PAS	107/116A/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS is based on GEIA-STD-0005-2 and is published as a double logo PAS. GEIA, Government Electronics and Information Technology Association, has been transformed into TechAmerica Association.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This PAS is intended for use by those procuring, designing, building or repairing electronic assemblies that will use items with Pb-free tin finishes to document processes they use to assure performance, reliability, airworthiness, safety, and certifiability of those assemblies. It provides a framework to communicate and agree on the processes to be used to control and mitigate the use of Pb-free tin in these applications.

The Aerospace Industries Association (AIA), the Avionics Maintenance Conference (AMC), and Government Electronics and Information Technology Association (GEIA) formed a joint working group with the express purpose of generating a series of industry standards documents for the use and handling of Pb-free solder, piece parts, and boards in aerospace and high performance applications. This PAS – originally published as GEIA-STD-0005-2 – was prepared by that group. It was balloted and approved by GEIA G-12 (Solid State Subcommittee) and GEIA Avionics Management Conference (AMC Subcommittee). According agreements between GEIA and IEC, this PAS is extended at international level.

This PAS is intended to work in concert with IEC/PAS 62647-1 (based originally on GEIA-STD-0005-1), GEIA-HB-0005-1 [1], GEIA-HB-0005-2 [2]. This PAS may be referenced in proposals, requests for proposals, work statements, contracts, and other documents. It may be used as a stand-alone standard or as part of compliance with IEC/PAS 62647-1.

This PAS addresses the risk of tin whiskers. However, the state of research into tin whisker risk still does not allow accurate quantitative estimates of the risk and reliability. It defines three baseline control levels that detail the amount of attention that should be paid to the risk of tin whiskers: no restrictions on tin use, some restrictions on tin use, and prohibition of tin use.

There are three informative annexes in this PAS:

– Annex A provides guidance on selecting control levels and performing risk assessments;
– Annex B describes mechanisms of formation, properties, and potential deleterious effects of tin whiskers;
– Annex C provides some background on various mitigation methods.

Due to a variety of real and potential health issues, many constituent materials used in the production of electronic products have come under scrutiny. The European Union (EU) has enacted two directives; 2002/95/EC Restriction of Hazardous Substances (RoHS) and 2002/96/EC Waste Electrical and Electronic Equipment (WEEE) that restrict or eliminate the use of various substances in a variety of products that are produced after July 2006. One of the key materials restricted is lead (Pb), which is widely used in electronic solder and electronic piece part terminations, and printed wiring boards. While these regulations may appear to only affect products for sale in the EU, due to the reduced market share of the Aerospace and High Performance Industry in electronics, many of the lower tier suppliers are changing their products because their primary market is consumer electronics. Additionally, several U.S. states have enacted similar “green” laws, and many Asian electronics manufacturers have recently announced completely “green” product lines.

The restriction of Pb use has generated a transition by many piece part and board suppliers from tin-lead (Sn-Pb) surface finishes to pure tin or other Pb-free finishes. Lead-free tin finishes can be susceptible to the spontaneous growth of crystal structures known as “tin whiskers” which can cause electrical failures, ranging from parametric deviations to catastrophic short circuits, and may interfere with sensitive optical surfaces or the movement

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[1] A future IEC/PAS 62647-21, based on GEIA-HB-0005-1, is in preparation.

[2] A future IEC/PAS 62647-22, based on GEIA-HB-0005-2, is in preparation.

of Micro-ElectroMechanical Systems (MEMS). Though studied and reported for decades, the mechanism behind their growth is not well understood, and tin whiskers remain a potential reliability hazard. Furthermore, the growing number of piece parts with pure tin finishes means there are more opportunities for whiskers to grow and to produce failures.

PROCESS MANAGEMENT FOR AVIONICS – AEROSPACE AND DEFENCE ELECTRONIC SYSTEMS CONTAINING LEAD-FREE SOLDER –

Part 2: Mitigation of the deleterious effects of tin

1 Scope

This PAS establishes processes for documenting the mitigating steps taken to reduce the harmful effects of tin finishes in electronic systems.

This PAS is applicable to Aerospace and High Performance electronic applications which procure equipment that may contain Pb-free tin finishes.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

2.1
assemblies
electronic items that require electrical attachments, including soldering of wires or component terminations; examples include circuit cards and wire harnesses. This may include soldered assemblies

2.2
bright tin
tin finish with higher internal stresses and smaller grain size of 0,5 μm to 0,8 μm and carbon content of 0,2 % to 1,0 %

2.3
critical
item or function, if defective, will result in the system's inability to retain operational capability, meet primary objective, or affect safety

2.4
customer
entity or organization that (a) integrates a piece part, soldered assembly, unit, or system into a higher level system, (b) operates the higher level system, or (c) certifies the system for use. For example, this may include end item users, integrators, regulatory agencies, operators, original equipment manufacturers (OEMs), and subcontractors

2.5
energy dispersive (X-ray) spectroscopy
EDS
method for material composition analysis

2.6
high performance system or product
system or product which requires continued high performance or performance on-demand, or equipment downtime cannot be tolerated, or end-use environment may be uncommonly harsh and the equipment must function when required, such as life support or other critical systems

2.7
lead-free
defined as less than 0,1 % by weight of lead in accordance with Waste Electrical and Electronic Equipment (WEEE) guidelines

2.8
matte tin
tin finish with lower internal stresses and larger grain sizes typically of 1 μm or greater and carbon content less than 0,050 %

2.9
Pb-free tin
tin defined to be pure tin or any tin alloy with <3 % lead (Pb) content by weight. This means that some Pb-free finishes other than pure tin, such as tin-bismuth and tin-copper, are considered to be “tin” for the purposes of this PAS. Many of these alloys have not been assessed for whiskering behavior

2.10
Pb-free tin finish
Pb-free tin final finishes or underplates either external or internal to a device, board or other hardware. This includes all leads and surfaces, even those coated, encapsulated, or otherwise not exposed. It may include finishes on electrical piece parts, mechanical piece parts, and boards. It does not include Pb-free bulk solders, assembly materials, solder balls, or those devices where the Pb-free tin finish has been completely replaced

2.11
piece part
electronic component that is not normally disassembled without destruction and is normally attached to a printed wiring board to perform an electrical function

2.12
rework
act of reprocessing non-complying articles, through the use of original or equivalent processing in a manner that assures full compliance of the article with applicable drawings or specifications

2.13
repair
act of restoring the functional capability of a defective article in a manner that precludes compliance of the article with applicable drawings or specifications

2.14
sub-contractor
organization, within the given high-reliability industry, that supplies, maintains, repairs, or supports electronic systems, and is not the direct supplier to the customer or user of those systems

2.15
supplier
entity or organization that designs, manufactures, repairs, or maintains a piece part, unit, or system. For example, this includes original equipment manufacturers (OEMs), repair facilities, subcontractors, and piece part manufacturers. In some cases, a single organization may be both a customer and a supplier. They should follow the requirements for suppliers when addressing their customer’s contracts and should follow the requirements for customers when flowing down requirements to their lower tier suppliers

2.16
system
one or more units that perform electrical function(s)

2.17
tin whisker
spontaneous crystal growth that emanates from a tin surface. They may be cylindrical, kinked, or twisted. Typically they have an aspect ratio (length/width) greater than two, with shorter growths referred to as nodules or odd-shaped eruptions (OSEs). See Annex B for further description of tin whiskers and their physical attributes

2.18
unit
one or more assemblies within a chassis to perform electrical function(s)

2.19
X-ray fluorescence
XRF
method for material composition analysis

3 Requirements

3.1 Determination of levels

The customer is responsible for determining the control level they are seeking and identify it in their request for proposal when this PAS is imposed. They should also determine the level of oversight and review the program will require. For some programs, different control levels may be required for different products. In these cases, the customer is responsible for defining these different levels and their applications or define a process by which they and the supplier will determine the levels.

The customer and supplier shall agree on the control levels and shall document this agreement in appropriate control documents.

There will be cases where errors will be made in the finish determination or in the application of mitigation methods. Customers and suppliers should have processes in place to document and assess the impact of these errors. Already existing deviation or waiver processes may be acceptable if technical experts on tin whiskers are consulted.

3.2 Requirements for control levels

3.2.1 General

Each program or system has the responsibility of determining the appropriate control level for their product. This document is not intended to imply that any category of aerospace or high performance application is more or less reliable or critical than any other category; nor is it intended to imply that any aerospace or high performance system will be more or less reliable, depending on the control level that is selected from the above list. Reliability is assured by a wide range of design, production, use, and support decisions and activities, of which tin whisker mitigation is only one. It is expected that, whatever level of mitigation category is used, the system reliability will be assured by the totality of all the methods available to the producer and user of the system.

There are many aspects to tin whisker control. For the purposes of this PAS, the activities have been grouped into four categories:

– documentation of uses of Pb-free tin;
– detecting and controlling Pb-free tin introduction;
– tin whisker risk mitigation;
– tests and analyses of tin whisker risk and mitigation effectiveness.

If only Level 2, with no sub-level, is identified in a control document, the default level *shall* be assumed to be Level 2A.

3.2.2 Control Level 1 requirements

3.2.2.1 Requirements for documentation of uses of Pb-free tin

There are no requirements. The supplier should provide general information regarding types of platings, finishes, and solder used and plans for process controls on those processes in accordance with 3.3.1. If the supplier is unable to determine some materials, this shall be stated.

3.2.2.2 Requirements for detecting and controlling Pb-free tin finish introduction

No requirements.

3.2.2.3 Requirements for tin whisker risk mitigation

No requirements.

3.2.2.4 Requirements for tests and analyses of tin whisker risk and mitigation effectiveness

No requirements.

3.2.3 Control Level 2A requirements

3.2.3.1 Requirements for documentation of uses of Pb-free tin

There are no supplier requirements. The supplier should provide general information regarding types of platings, finishes, and solder used and plans for process controls on those processes in accordance with 3.3.1. If the supplier is unable to determine some materials, this shall be stated.

The customer is responsible for listing any applications where Pb-free tin is not allowed.

3.2.3.2 Requirements for detecting and controlling Pb-free tin finish introduction

No requirements.

3.2.3.3 Requirements for tin whisker risk mitigation

The supplier shall provide descriptions of any mitigation methods assumed to be in use for the tests and analyses in 3.2.3.4. The supplier shall provide descriptions of any mitigation measures taken for hardware.

The customer is responsible for defining any mitigation measures that are required or disallowed.

3.2.3.4 Requirements for tests and analyses of tin whisker risk and mitigation effectiveness

The supplier shall provide an analysis addressing the risk of tin whiskers in accordance with 3.3.4. This analysis is expected regardless of whether mitigations are applied. If no mitigations are applied, the analysis should demonstrate why they are not needed. If mitigations are applied, the analysis should demonstrate that they are effective.

For Level 2A, these analyses may be performed at the process level. For example, the analysis might address all devices with a particular mitigation technique employed.

3.2.3.5 Exceptions

Specific piece parts, soldered assemblies, units, or applications may be required to meet a higher level of control. These requirements shall be specified in contractual documents.

3.2.4 Control Level 2B requirements

3.2.4.1 General

For Level 2B hardware, these control plans may cover families of piece part types or applications. Separate assessments and control plans for each individual item are not required. For example, one assessment might allow use of all tin-plated capacitors in a variety of applications.

3.2.4.2 Requirements for documentation of uses of Pb-free tin

The supplier shall provide lists of families of tin-finished piece parts and/or location and material information for categories of applications where they would like to use Pb-free tin in accordance with 3.3.1.2. If there are other uses of tin, the supplier shall provide a list of additional specific applications of Pb-free tin that fall outside these families in accordance with 3.3.1.3. If the supplier is unable to determine some materials, this shall be stated.

The customer is responsible for listing any applications where Pb-free tin is not allowed.

3.2.4.3 Requirements for detecting and controlling Pb-free tin finish introduction

The supplier should provide a plan for monitoring materials on a sample basis, including method of test and sampling scheme, in their product in accordance with 3.3.2.1.

3.2.4.4 Requirements for tin whisker risk mitigation

The customer is responsible for defining any mitigation measures that are required or disallowed.

The supplier shall implement the mitigating measures contractually required by the customer.

It is recommended that at least two mitigation measures in accordance with 3.3.3 be required and performed.

3.2.4.5 Requirements for tests and analyses of tin whisker risk and mitigation effectiveness

If a specific risk algorithm or other method for evaluation measure is required, the customer is responsible for describing them in the request for proposal. The customer is also responsible for communicating any documentation review or oversight requirements to the supplier.

The supplier shall have documentation covering the following elements:

– the mitigation measures taken for each family of piece parts or applications of Pb-free tin finish in the product;

– the tests or analyses performed for each family of piece parts or applications using Pb-free tin finishes, to determine risk of whisker growth in accordance with 3.3.4;

– if there are other uses of Pb-free tin outside the families, the mitigation measures taken for each piece part or application of Pb-free tin finish in the product outside the families;

– if there are other uses of Pb-free tin outside the families, the tests and analyses performed for each of these piece parts or applications to determine risk of whisker growth in accordance with 3.3.4;