



BSI Standards Publication

Process management for avionics — Aerospace and defence electronic systems containing lead-free solder

Part 2: Mitigation of deleterious effects of tin

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National foreword

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TECHNICAL SPECIFICATION



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XB**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 2: Mitigation of deleterious effects of tin

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC/TS 62647-2, which is a technical specification, has been prepared by IEC technical committee 107: Process management for avionics.

The text of this technical specification is based on the following documents: IEC/PAS 62647-2 and GEIA-STD-0005-2 Revision A.

This technical specification cancels and replaces IEC/PAS 62647-2.

A list of all the parts in the IEC 62647 series, published under the general title *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder*, can be found on the IEC website.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
107/160/DTS	107/193/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

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 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, defence, and high performance industry in electronics, many of the lower tier suppliers are changing their products because their primary market is world-wide consumer electronics. Additionally, several Asian countries and United States (U.S.) states have enacted similar “green” laws. 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 (SnPb) 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 of micro-electro mechanical systems (MEMS) for example. 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.

It is important to state that that the nature and meaning of ‘risk’ posed by tin whiskers may vary considerably across the range of users of this Specification. As in any assessment of risk, the probability of occurrence and failure and consequence of occurrence and failure should be considered in each application. Potential whisker failure modes for a particular hardware/system application must be carefully considered when making the choice/determination of which control level(s) to apply. For example, whisker-prone leaded parts on circuit card used in a system that is under frequent/continual power may only incur parametric deviations or interrupts as individual whiskers grow and short to an adjacent lead. On the other hand, the same circuit card, employed in a missile subject to years of dormant storage, could grow many long whiskers into potentially catastrophic shorting conditions but the shorts will not occur until the missile is launched toward its target and results in mission failure. For the purposes of this Specification, risk refers to the chance and consequence of a failure due to a whisker, not just the chance of the presence of a whisker.

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

Part 2: Mitigation of deleterious effects of tin

1 Scope

This Technical Specification establishes processes for documenting the mitigating steps taken to reduce the harmful effects of Pb-free tin in electronic systems.

This Technical Specification is applicable to aerospace, defence, and high performance (ADHP) electronic applications which procure equipment that may contain Pb-free tin finishes.

This document may be used by other high-performance and high-reliability industries, at their discretion.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/TS 62647-1:2012, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 1: Preparation for a lead-free control plan*¹

IEC/PAS 62647-3, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 3: Performance testing for systems containing lead-free solder and finishes*²

IEC/PAS 62647-21, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 21: Program management – Systems engineering guidelines for managing the transition to lead-free electronics*³

IEC/PAS 62647-22, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 22: Technical guidelines*⁴

ANSI/GEIA-STD-0006, *Requirements for using solder dip to replace the finish on electronic piece parts*

ANSI Z1.4, *Sampling procedures and tables for inspection by attributes*

IPC J-STD-001, *Requirements for soldered electrical and electronic assemblies*

¹ Previously known as GEIA-STD-0005-1.

² Previously known as GEIA-STD-0005-3. IEC/PAS 62647-3 is in the process of being revised and will be issued as IEC/TS 62647-3.

³ Previously known as GEIA-HB-0005-1. IEC/PAS 62647-21 is in the process of being revised and will be issued as IEC/TS 62647-21.

⁴ Previously known as GEIA-HB-0005-2. IEC/PAS 62647-22 is in the process of being revised and will be issued as IEC/TS 62647-22.

IPC-CC-830, *Qualification and performance of electrical insulating compounds for printed wiring assemblies*

JESD201, *Environmental acceptance requirements for tin whisker susceptibility of tin and tin alloy surface finishes*

JESD213, *Standard test method utilizing X-ray fluorescence (XRF) for analyzing component finishes and solder alloys to determine Tin (Sn) – Lead (Pb) content*

MIL-STD-1580, *Destructive physical analysis for electronic, electromagnetic, and electromechanical parts*

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1

assemblies

electronic items that require electrical attachments, including soldering of wires or component terminations

EXAMPLE Circuit cards and wire harnesses.

[SOURCE: IEC/TS 62647-1:2012, 3.1]

3.1.2

critical

state of an item or function, which if defective, will result in the system's inability to retain operational capability, meet primary objective, or affect safety

[SOURCE: IEC/TS 62647-1:2012, 3.2]

3.1.3

control level

amount of attention that should be paid to the risk of tin whiskers (i.e., no restrictions on tin use, some restrictions on tin use, and prohibition of tin use)

3.1.4

conformal coat

insulating protective covering that conforms to the configuration of the objects coated (e.g., printed boards, printed board assembly) providing a protective barrier against deleterious effects from environmental conditions

3.1.5

COTS

commercial-off-the-shelf

item whose design and configuration is controlled by the manufacturer and on which the user has no control with regard to the design and configuration

Note 1 to entry: An item may be a component, a sub-assembly, an assembly, a system.

3.1.6

COTS assemblies or sub-assembly

assembly or sub-assembly developed by a supplier for multiple customers, whose design and configuration is managed by the suppliers or an industry specification

[SOURCE: IEC/TS 62647-1:2012, 3.4]

3.1.7
customer

entity or organization that (a) integrates a piece part, soldered assembly, unit, or system into a higher control level system, (b) operates the higher control level system, or (c) certifies the system for use

EXAMPLE This may include end item users, integrators, regulatory agencies, operators, original equipment manufacturers (OEMs), and subcontractors.

[SOURCE: IEC/TS 62647-1:2012, 3.5]

3.1.8
EDS
energy dispersive (X-ray) spectroscopy
method for material composition analysis

3.1.9
encapsulation
process which involves the surrounding of (a) component(s) or an assembly with a liquid resin

3.1.10
gap
minimum line of sight distance between tin surface and the nearest adjacent conductor at a different potential.

Note 1 to entry: It refers to any conductors (leads, pads, connectors, contacts, or others).

3.1.11
high voltage
voltage level required to cause a plasma event

3.1.12
high performance
continued performance or performance on demand where an application (product, equipment, electronics, system, program) down time cannot be tolerated in an end-use environment which can be uncommonly harsh, and the application must function when required

EXAMPLE: Examples of high performance applications are life support or other critical systems.

[SOURCE: IEC/TS 62647-1:2012, 3.7]

3.1.13
lead-free
defined as less than 0,1 % by weight of lead in accordance with reduction of hazardous substances(RoHS) guidelines guidelines

[SOURCE: IEC/TS 62647-1:2012, 3.8]

3.1.14
mitigation
method to reduce the risk or consequence of a whisker failure over a period of several years.

Note 1 to entry: This does not imply that the risk is driven to zero, simply that the risk or consequence is reduced in some significant way.

3.1.15
Pb-free tin
pure tin or any tin alloy with < 3 % lead (Pb) content by weight

Note 1 to entry: 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 specification. Many of these alloys have not been assessed for whiskering behaviour.

[SOURCE: IEC/TS 62647-1:2012, 3.11]

3.1.16

Pb-free tin finish

final finishes or underplates either external or internal to a device, board or other hardware, including all leads and surfaces, even those coated, encapsulated, or otherwise not exposed

Note 1 to entry: 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 (consistent with GEIA-STD-0006).

[SOURCE: IEC/TS 62647-1:2012, 3.12]

3.1.17

plasma event

destructive arcing event that can occur at altitudes from sea level to space depending on voltage and current levels

3.1.18

piece part

piece component

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

[SOURCE: IEC/TS 62647-1:2012, 3.14]

3.1.19

potting

encapsulation process which involves the surrounding of a component(s) or an assembly in a container with a liquid resin which is then cured in place

Note 1 to entry: The container usually becomes an integral part of the system such that the critical property that needs to be maintained is the interfacial adhesion between the cured resin system and the container substrate and critical components for an optimum long-lasting reliable package.

3.1.20

rework

action taken to return a unit (SRU/LRU/system) to a state meeting all requirements of the engineering drawing, including both functionality and physical configuration by making repairs

Note 1 to entry: Also used to define the 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.

[SOURCE: IEC/TS 62647-1:2012, 3.16]

3.1.21

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

[SOURCE: IEC/TS 62647-1:2012, 3.17]

3.1.22

risk

probability of a failure due to a tin whisker

Note 1 to entry: It is not used with regards to the risk of the presence of a whisker or nodule.

3.1.23

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

[SOURCE: IEC/TS 62647-1:2012, 3.22]

3.1.24

supplier

refers to an entity or organization that designs, manufactures, repairs, or maintains a piece part, unit, or system

Note 1 to entry: This includes original equipment manufacturers (OEMs), repair facilities, subcontractors, and piece part manufacturers.

[SOURCE: IEC/TS 62647-1:2012, 3.23]

3.1.25

system

one or more units that perform electrical function(s)

[SOURCE: IEC/TS 62647-1:2012, 3.24]

3.1.26

tin whisker

spontaneous crystal growth that emanates from a tin (Sn) surface and which may be cylindrical, kinked, or twisted

Note 1 to entry: Typically tin whiskers have an aspect ratio (length/width) greater than two, with shorter growths referred to as nodules or odd-shaped eruptions (OSEs).

[SOURCE: IEC/TS 62647-1:2012, 3.26]

3.1.27

unit

one or more assemblies within a chassis or higher level system to perform electrical function(s)

[SOURCE: IEC/TS 62647-1:2012, 3.27]

3.1.28

XRF

X-ray fluorescence

method for material composition analysis

3.2 Abbreviations

ADHP	Aerospace, defence and high performance
COTS	Commercial off the shelf
EDX	Energy-dispersive X-ray spectroscopy
FMEA	Failure mode effects analysis
FMECA	Failure mode effects and criticality analysis
FOD	Foreign object damage
IMC	Intermetallic compound
iNEMI	international Electronics Manufacturing Initiative

JEDEC	Joint Electron Device Engineering Council
MEMS	Micro-electro mechanical systems
OEM	Original equipment manufacturer
OSD	Odd-shaped eruptions
Pb	Lead
PLCC	Plastic leaded chip carrier
PQFP	Plastic quad flat pack
QFP	Quad flat pack
REE	Rare earth elements
SEM	Scanning electron microscope
Sn	Tin
Sn-Pb	Tin/lead
SOIC	Small outline integrated circuit
TQFP	Thin quad flat pack
TSOP	Thin small outline package
XRF	X-ray fluorescence

4 Technical requirement

This specification 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 bring credit of certification 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

This specification is intended to be used in concert with IEC/TS 62647-1, IEC/PAS 62647-21, and IEC/PAS 62647-22. This specification may be referenced in proposals, requests for proposals, work statements, contracts, and other documents. It may be used as a stand-alone specification or as part of compliance with IEC/TS 62647-1.

This specification 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 five informative annexes in this specification:

- Annex A provides guidance on selecting control levels and performing risk assessments;
- Annex B provides some background on various mitigation methods;
- Annex C provides guidelines for performing tin whisker inspections;
- Annex D provides some additional guidance on tin whisker risk analyses;
- Annex E provides information on whiskers growing from bulk solder and joints.

4.1 Control level requirements

4.1.1 General

The supplier shall clearly state the control levels and shall document agreement by the customer in appropriate requirement or lead-free control plan documents. Customers are responsible for determining the control level they are seeking and identify it in their request for proposal and contract when this specification is imposed.

Higher control levels impose tighter controls and thereby reduce exposure to tin whisker risk. However, tin whisker risks are just one of many types of risks associated with component selection and assembly design. Controls imposed on tin whiskers should be commensurate with controls imposed to manage these other risks. 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 ADHP application is more or less reliable or critical than any other category nor is it intended to imply that any ADHP system will be more or less reliable, depending on the control level that is selected. 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 control 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.

In particular, it is recommended that the selection of control level involves consideration of the following questions:

- What are the consequences of performance anomalies in your system?
- Do we anticipate that the whiskers will produce a plasma event?
- Do local anomalies affect top-level system performance?
- Could a failure cause a critical failure or defeat redundancy?
- Are anomalies detectable and repairable?

More information on how these questions can be used to select an appropriate control level is provided in Annex A.

Overall, there are three approaches to tin whisker control:

- tin part avoidance;
- whisker risk mitigation;
- whisker risk acceptance.

Different control levels represent different emphasis on each of these approaches.

- Control level 1: Under control level 1 tin whisker risks are accepted. It is expected that this control level will primarily apply to developmental models, test equipment, and other units that will not be fielded.
- Control level 2: Under control level 2, Pb-free tin is sometimes acceptable. Tin whisker risk is managed primarily by a combination of design rules, mitigations, and avoidance. The sub-control level under control level 2 determines the emphasis given to each of these strategies. If only control level 2, with no sub-control level, is identified in a control document, the default level shall be assumed to be control level 2A.
- Control level 2A: Under level 2A, tin whisker risks are managed primarily through the acceptance of tin whisker risk, and to a lesser extent upon the use of design rules. This control level was designed primarily for lower criticality applications. Tin is permitted for use in all applications except where specially restricted.
- Control level 2B: Under control level 2B, tin whisker risks are managed primarily through the use of design rules, and to a lesser extent upon tin avoidance. This control level was primarily designed for non-critical boards or units or boards and units with good redundancy used in systems with moderate to high failure consequences.
- Control level 2C: Under control level 2C, tin whisker risks are managed primarily by tin avoidance, and in exceptional cases, by design rules. This control level was primarily designed for critical boards with limited redundancy used in systems with moderate to high failure consequences.

Control level 3: Tin whisker control is managed strictly by tin avoidance. This level was designed for units and boards where failures cannot be tolerated.

For units or boards that apply a mix of design rules and individual Pb-free tin evaluations, the unit or board shall be defined as control level 2B, with the rules defining the circumstances requiring control level 2C-like evaluations clearly called out. Applications falling within the control level 2C-like requirements shall be documented and mitigated per the requirements of control level 2C.

Control levels are expected to be applied at the unit or board control level, consistent with the overall risk strategy for that unit or board. However, an overall strategy for higher control levels of integration may be appropriate and is discussed in 4.1.2 below.

4.1.2 Control levels and levels of integration

Control levels were designed to be applied at the unit or board control level, but customers may want to have an approach to control levels and level selection at the subsystem, product, or system control level. Some approaches at higher control levels of integration and in system lead-free control plans:

- define the criteria that are to be used to evaluate unit control levels, preferably with some general statements about what control levels are expected on most units and boards;
- define control levels based on unit criticality, function, or some other design rule;
- define the system level control level based on the expected control level of most units and define when the program will require higher control levels. A discussion of this process for requiring higher or allowing lower control levels should be included.

4.1.3 COTS and level selection

The imposition of control levels 2C and higher will generally preclude the use of COTS assemblies and systems, unless directed or authorized by their customer. If COTS assemblies are used in a program or system that is defined as control level 2C or 3, they shall be identified and treated as exceptions or a comprehensive material control and analysis plan shall be implemented or the material and mitigations requirements will be flowed down to and accepted by the COTS supplier. In a control level 2B situation, the treatment of COTS shall be addressed in the list of families where Pb-free tin alloys will be used or the materials and mitigations requirements will be flowed down to and accepted by the COTS supplier.

COTS parts may be used under any level but need to be evaluated as any part or finish and meet the requirements of the control level. This will likely involve at least one of the following:

- working with the part supplier to understand the material and mitigating as necessary;
- managing material identification for any lot or subset of parts with known uniformity of finish and mitigating materials as necessary;
- treating all COTS material as Pb-free tin and performing mitigations on all as required.

4.1.4 Other level selection information

Annex A provides additional guidance on level selection.

Note that these levels are different than the IPC Product Classes described in IPC J-STD-001E-2010 (IEC 61191). In general, it is expected that most users of this specification are IPC Class 3 due to the types of final end applications their products support.

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.

4.2 Requirements for control levels

4.2.1 Control level 1 requirements

4.2.1.1 Control level 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.

4.2.1.2 Control level 1 requirements for detecting and controlling Pb-free tin finish introduction

There are no requirements.

4.2.1.3 Control level 1 requirements for tin whisker risk mitigation

There are no requirements.

4.2.1.4 Control level 1 requirements for parts selection

There are no requirements.

4.2.1.5 Control level requirements for analysis and documentation of risk and mitigation effectiveness

There are no requirements.

4.2.2 Control level 2A requirements

4.2.2.1 Control level 2A requirements for documentation of uses of Pb-free tin

The supplier shall document the design rules that are in place for determining when Pb-free tin is not acceptable or when mitigations are required.

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

4.2.2.2 Control level 2A requirements for detecting and controlling Pb-free tin finish introduction

There are no requirements.

4.2.2.3 Control level 2A requirements for tin whisker risk mitigation

The plan should indicate any mitigation that is applied as part of the general process at the supplier.

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

4.2.2.4 Control level 2A requirements for parts selection

Unless the parts list or vendor list is provided by the customer, the supplier should have a part selection process that encourages the use of parts that have lower tin whisker risk, consistent with the requirements presented in 4.5.

4.2.2.5 Control level 2A requirements for analysis and documentation of risk and mitigation effectiveness

This analysis is expected regardless of whether mitigations are applied.

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

4.2.2.6 Control level 2A exceptions

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

4.2.3 Control level 2B requirements

4.2.3.1 General

If the control level is defined at a system or assembly control level, this is the control level that will most likely be selected if the use of Pb-free tin will be dependent on function or criticality of elements of the assembly or system.

4.2.3.2 Control level 2B requirements for documentation of uses of Pb-free tin

For control level 2B hardware, the control plans may cover families of piece part types or applications or individual uses. Separate assessments and control plans for each individual item are NOT required for items within these classes. For example, one assessment might allow use of tin-plated capacitors in a variety of applications. For Pb-free tin items not within the classes, specific plans and assessment are required.

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 4.6. If there are other individual uses of tin, the supplier shall provide a list of additional specific applications of Pb-free tin that fall outside these families. 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.

The definition of high voltage applications shall be documented. Pb-free tin usage in high voltage applications and their mitigations shall be documented separately and identified as high voltage.

4.2.3.3 Control level 2B 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 4.3.3.

4.2.3.4 Control level 2B requirements for tin whisker risk mitigation

Uses of Pb-free tin require mitigation. For non-high voltage applications, mitigation requirements shall be fulfilled by any one of the following:

- Hard potting or encapsulation
- Physical barriers
- Circuit design and analysis showing low impact of tin whisker short or FOD
- Circuit design and analysis showing that areas sensitive to tin whisker shorts or FOD have at least a 1 cm gap
- Conformal coating with validated coverage and gap size greater than 250 microns
- Pb-free tin electronic components with gaps greater than 2 000 microns that have been installed with SnPb and are physically isolated from any Pb-free tin mechanical piece parts

- SnPb soldering process with validated complete coverage
- Mitigation or combination of mitigations approved by the customer

Specific requirements for each mitigation listed above are presented in 4.4.

High voltage applications shall have a mitigation or a combination of mitigations approved by the customer or customer representative.

4.2.3.5 Control level 2B requirements for parts selection

Unless the parts list or vendor list is provided by the customer, the supplier shall have a part selection process that encourages the use of parts that have lower tin whisker risk. The parts selection process shall document what specific part control level characteristics are considered to be preferred. The process should describe how risks are weighed when deciding if part control level mitigations are applied or not. The documentation of the process shall be made available to the customer upon request.

Recommendations about characteristics of lower risk tin parts are presented in 4.5.

4.2.3.6 Control level 2B requirements for assessment and documentation of risk and mitigation effectiveness

The supplier shall provide an analysis addressing the risk of tin whiskers in accordance with 4.6, including rationale for the selection of control level 2B, unless the control level selection was dictated by the customer.

The supplier shall have documentation covering the following elements:

- Methods of controlling vendor use and introduction of Pb-free tin
- Mitigation measure(s) taken for each family of piece parts or applications of Pb-free tin finish in the product
- 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 4.6
- 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 4.6
- Verification methods, including inspections and tests, that show their processes are under control
- Risk assessment and mitigation measures to the customer for their review, as requested or required by customer

This documentation shall be made available for review, as requested or required by the customer.

4.2.4 Control level 2C requirements

4.2.4.1 General

Applications of tin shall be reviewed and approved individually by an authorized customer representative in accordance with established design rules. Approval of exceptional cases can occur within the requirements of the plan. For example, instead of one assessment and mitigation plan covering all tin-plated capacitors, each capacitor type and application shall be reviewed and approved, even if the same strategy is applied to each situation.

4.2.4.2 Control level 2C requirements for documentation of uses of Pb-free tin

The supplier shall avoid use of Pb-free tin whenever possible. Individual uses of Pb-free tin shall be documented and mitigated and require approval by the customer or customer designee.

The definition of high voltage applications shall be documented.

The supplier shall provide a plan for passing the requirement to lower control level suppliers in accordance with 4.3.1.

4.2.4.3 Control level 2C requirements for detecting and controlling Pb-free tin finish introduction

The supplier shall provide a plan for monitoring materials in their product in accordance with 4.3.3. The supplier and customer shall reach an agreement regarding this plan.

For critical piece parts, assemblies or systems, the plan should include sampling at least one part per lot of all piece parts not approved for tin.

4.2.4.4 Control level 2C requirements for tin whisker risk mitigation

For non-high voltage applications, mitigation requirements shall be fulfilled by at least one of the following:

- Hard potting or encapsulation
- Physical barriers
- Circuit design and analysis showing low impact of tin whisker short or FOD
- SnPb soldering process with validated complete coverage
- Conformal coat with validated coverage and gap greater than 500 µm
- A combination of mitigations approved by the customer

Specific requirements for each mitigation listed above are presented in 4.4.

High voltage applications shall have a mitigation or a combination of mitigations approved by the customer or customer representative.

4.2.4.5 Control level 2C requirements for parts selection

Unless the parts list or vendor list is provided by the customer, the supplier shall have a part selection process that encourages the use of parts that have lower tin whisker risk. The parts selection process shall document what specific part control level characteristics are considered to be preferred. The process should describe how risks are weighed when deciding if part control level mitigations are applied or not. The documentation of the process shall be made available to the customer upon request.

Recommendations about characteristics of lower risk tin parts are presented in 4.5.

4.2.4.6 Control level 2C requirements for assessment and documentation of risk and mitigation effectiveness

The customer is responsible for describing the risk algorithm or other methods for evaluating mitigation measures in the request for proposal, if applicable. 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 piece part or application of Pb-free tin finish in the product.
- The tests and analyses performed for each piece part or application using Pb-free tin finishes, to determine the risk of whisker growth in accordance with 4.6.
- Provide the risk assessment and mitigation measures to the customers for their review, as requested or required by customers.

4.2.5 Control level 3 requirements

4.2.5.1 General

The supplier shall not allow use of Pb-free tin finish.

No Pb-free finishes may be designed into the product or knowingly purchased without a plan to replace the finish. Any uses of Pb-free tin are considered a deviation from the requirements and require deviation, waiver, or other non-conformance documentation.

4.2.5.2 Control level 3 requirements for documentation of uses of Pb-free tin

The supplier shall provide a plan for passing the requirement to lower control level suppliers as per 4.3.1.

Any use of Pb-free tin finish would represent a violation of requirements, which would require a waiver process based on program requirements, including risk management requirements.

4.2.5.3 Control level 3 requirements for detecting and controlling Pb-free tin finish introduction

The supplier shall monitor the material in their product as per 4.3.4.

4.2.5.4 Control level 3 requirements for mitigation of tin whisker risk and mitigation effectiveness

This is not applicable, as Pb-free tin finish is not allowed.

4.2.5.5 Control level 3 requirements for parts selection

This is not applicable, as Pb-free tin finish is not allowed.

4.2.5.6 Control level 3 requirements for assessment and documentation of risk and mitigation effectiveness

This is not applicable, as Pb-free tin finish is not allowed.

4.2.6 Requirements for mitigating tin whisker risk for solder joints

The majority of requirements in this specification apply to Pb-free tin finishes, not Pb-free solders. This is because the control level of understanding for tin whiskers growing from finishes is much higher than from solders. However, the data on the dangers of tin whiskers growing from Pb-free and SnPb solders when there are rare earth elements (REE) present is sufficient to consider these solders a risk.

For control level 2, use of Pb-free or SnPb solders with intentionally alloyed REE shall be disclosed to the customer and a risk assessment performed with regards to tin whiskers.

For control level 3, use of Pb-free or SnPb solder with intentionally alloyed REE shall be prohibited.

Additional information and recommendations for tin whisker inspection are presented in Annex C. Information and recommendations for preventing tin whiskers growing from Pb-free solder joints are presented in Annex E.

4.3 Implementation methods

4.3.1 Flowing requirements to lower level suppliers (applies to control level 2B, control level 2C, and control level 3)

Requirements for tin whisker control, analysis, and mitigation are applicable to all purchased and subcontracted elements and materials for the program. This may require flowing down these requirements to the lower level suppliers or performing extensive analysis of the purchased material. The supplier should be prepared to document how they addressed the risk from the purchased equipment if requested or required by the customer.

4.3.2 Detecting and controlling Pb-free tin finish introduction

The use of screens to monitor Pb-free tin finish depends in part on the lot uniformity requirements. Many standard lot definitions do not address finishes, only internal features. The sampling or lot monitoring plan should take the finish uniformity requirements into consideration.

4.3.3 Sample monitoring plans (applies to control level 2B and control level 2C)

A monitoring plan, including method of test and sampling scheme, should be documented for control level 2B and shall be documented for control level 2C.

For control level 2B, the monitoring plan and sampling scheme should focus on critical hardware where Pb-free tin is not allowed.

For critical hardware following control level 2C where approvals for use of Pb-free tin have not been obtained, the monitoring plan described in 4.3.4 should be used.

COTS parts may lack finish uniformity requirements, and thus may require higher sample sizes during material identification testing.

If X-ray fluorescence (XRF) spectroscopy is used for detection, the methods shall be consistent with JESD213. If energy dispersive (X-ray) spectroscopy (EDS) is used for detection, the methods shall be consistent with MIL-STD-1580:2010, notice 2, revision B. Other methods may be used with customer approval.

4.3.4 Lot monitoring requirements (applies to control level 3)

A lot screening program is required for all items with metallic finishes. Items containing metallic finishes shall be tested, at least one sample per lot or batch received, unless otherwise specified by the customer. A minimum of 3 % Pb by weight is required. The requirements for lot or batch uniformity should be documented to confirm that the monitoring plan is adequate. COTS parts may lack finish uniformity requirements, and thus may require higher sample sizes during material identification testing. If finish uniformity is not adequately addressed in lot or batch uniformity requirements, a sampling plan consistent with ANSI Z1.4 should be used.

If X-ray fluorescence (XRF) spectroscopy is used for detection, the methods shall be consistent with JESD213. If energy dispersive (X-ray) spectroscopy (EDS) is used for detection, the methods shall be consistent with MIL-STD-1580:2010, notice 2, revision B. Other methods may be used with customer approval.