EASA	NOTIFICATION OF A PROPOSAL TO ISSUE A CERTIFICATION MEMORANDUM
	**EASA Proposed CM No.:** **EASA Proposed CM - AS – 003 Issue: 01** **Issue Date: 17th of February 2014** **Issued by: Avionics Systems section** **Approved by: Head of Certification Experts Department** **Regulatory Requirement(s): CS-23, CS-25, CS-27, CS-29, CS-E, CS-APU, CS-ETSO**

In accordance with the EASA Certification Memorandum procedural guideline, the European Aviation Safety Agency proposes to issue an EASA Certification Memorandum (CM) on the subject identified below.

All interested persons may send their comments, referencing the EASA Proposed CM Number above, to the e-mail address specified in the "Remarks" section, prior to the indicated closing date for consultation.

EASA Certification Memoranda clarify the European Aviation Safety Agency's general course of action on specific certification items. They are intended to provide guidance on a particular subject and, as non-binding material, may provide complementary information and guidance for compliance demonstration with current standards. Certification Memoranda are provided for information purposes only and must not be misconstrued as formally adopted Acceptable Means of Compliance (AMC) or as Guidance Material (GM). Certification Memoranda are not intended to introduce new certification requirements or to modify existing certification requirements and do not constitute any legal obligation.

EASA Certification Memoranda are living documents into which either additional criteria or additional issues can be incorporated as soon as a need is identified by EASA.

Subject

Airworthiness Considerations for Lead (Pb) Free Electronics in Airborne Systems

Log of Issues

Issue	Issue date	Change description
01	17.02.2014	First issue.

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

The purpose of this Certification Memorandum is to make applicants aware of the need to assess the impact of the transition to lead-free electronics on the airworthiness of aircraft parts and appliances. It also directs applicants to appropriately mitigate any risks and provides guidance on the implications for demonstrating compliance with all the applicable requirements.

This Certification Memorandum describes how the impact of lead-free electronics can be assessed through the development of a Lead-Free Control Plan (LFCP). It also notes that one possible method for developing such a plan can be found in the standards and handbooks produced by the Government Electronics and Information Technology Association (GEIA).

For airborne functions having no impact on safety, this Certification Memorandum does not apply.

1.2. REFERENCES

It is intended that the following reference materials be used in conjunction with this Certification Memorandum:

Reference	Title	Code	Issue	Date
CS 2x.1301*	Function and Installation	CS-23, CS-25, CS-27, CS-29	---	---
CS 2x.1309*	Equipment, system and installations	CS-23, CS-25, CS-27, CS-29	---	---
CS 2x.1431(a)	Environmental Conditions	CS-23, CS-25, CS-29	---	---
CS 2x.1529	Instructions for Continued Airworthiness	CS-23, CS-25, CS-27, CS-29	---	---
CS-E 50*	Engine Control System	CS-E	---	---
CS-E 80*	Equipment	CS-E	---	---
CS-APU 90	APU Control System	CS-APU	---	---
CS-APU 210	Safety Analysis	CS-APU	---	---
CS-APU 480	Electronic Control System Components	CS-APU	---	---
ETSO Cx Paragraph 3.1.2	Environmental Standard	CS-ETSO	---	---
GEIA-STD-0005-1	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder **	---	---	---

Reference	Title	Code	Issue	Date
GEIA-STD-0005-2	Standard for Mitigating the Effects of Tin in Aerospace and High Performance Electronic Systems **	---	---	---
GEIA-STD-0005-3	Performance Testing for Aerospace and High Performance Electronics Containing Lead-free Solder and Finishes **	---	---	---
GEIA-HB-0005-1	Program Management / Systems Engineering Guidelines for Managing the Transition to Lead-free Electronics **	---	---	---
GEIA-HB-0005-2	Technical Guidelines for Aerospace and High Performance Electronic Systems Containing Lead-free Solder **	---	---	---
GEIA-HB-0005-3	Rework and Repair Handbook To Address the Implications of Lead-Free Electronics and Mixed Assemblies in Aerospace and High Performance Electronic Systems **	---	---	---
NASA Advisory NA-044 and NA-044A	Parts Advisory on Tin Whiskers	---	---	---
Air Force Airworthiness Advisory AA-05-01	Lead-Free Solder	---	---	---
Directive 2002/95/EC	The Restriction of the use of certain Hazardous Substances in electrical and electronic equipment	---	---	27 Jan 2003
Directive 2002/96/EC	Waste Electrical and Electronic Equipment	---	---	27 Jan 2003

* Associated Acceptable Means of Compliance and Guidance Material where applicable.

** http://www.techstreet.com/techam (Available for purchase)

1.3. SUPPORTING DOCUMENTS

The following supporting materials, while not directly referenced in this Certification Memorandum, may be of general interest:

Reference	Title	Code	Issue	Date
---	NASA Advisory NA-044: Parts Advisory on Tin Whiskers		---	---
---	Air Force Airworthiness Advisory AA-05-01, Lead-Free Solder			

1.4. ABBREVIATIONS

The following abbreviations are used in this Certification Memorandum:

Abbreviation	Meaning
AIA	Aerospace Industries Association
AMC	Avionics Maintenance Conference
CRI	Certification Review Item
GEIA	Government Electronics and Information Technology Association
IPT	Integrated Process Team
LEAP-WG	Lead-free Electronics in Aerospace Project Working Group
LFCP	Lead-Free Control Plan
MTBF	Mean Time Between Failures
NASA	National Aeronautics and Space Administration
OEM	Original Equipment Manufacturer
Pb	Lead (chemical element)
PCB	Printed Circuit Boards
PERM	Lead-free Electronics Risk Management Consortium
RoHS	Restriction of Hazardous Substances
Sn	Tin (chemical element)
SnPb	Tin-Lead (alloy)

1.5. DEFINITIONS

The following definitions are used in this Certification Memorandum:

Definition	Meaning
Tin Whiskers	Conductive crystalline out-growths from near-pure tin coatings. The phenomenon is not well-understood and no currently devised mitigations are 100% effective at preventing these structures from forming and causing electrical malfunctions and/or failures.

2. BACKGROUND

2.1. GENERAL

Avionics and other electronic applications that demand high reliability differ in significant ways from the vast majority of commercial and consumer electronic applications. For example, airborne electronics are expected to perform reliably in environments that often include extreme conditions: high-altitude, high levels of shock and vibration, rapid temperature changes, high humidity, etc. Unlike most commercial and consumer electronics, avionics product lifetimes are often measured in decades, rather than in years. Avionics are routinely maintained through repair activities that can even include replacing individual components on circuit boards. Most importantly, the failure of aircraft equipment may have safety consequences. For over 50 years, the electronics industry has relied on Tin-Lead (SnPb) solder as the primary means of interconnection between electronic components and devices.

The European Union's (EU) Restriction of Hazardous Substances (RoHS) directive (2002/95/EC) has recently forced the electronics industry to adopt solders and termination finishes free of Lead (Pb). Similar legislation is in place or underway in countries outside Europe. While aerospace and military electronics are excluded from these lead-free imperatives, many of their component suppliers are not. Even suppliers that initially may continue to provide traditional SnPb components for aerospace applications may find the cost of maintaining separate production lines too unattractive to continue doing so. In any case, the introduction and proliferation of lead-free components and Printed Circuit Boards (PCBs) throughout manufacturer supply chains is unavoidable and underway.

Based on the scientific information available today, there does not appear to be a replacement for SnPb solder that can provide exactly the same level of performance and reliability. While various alternatives are available, they may reduce reliability when used in airborne electronics. The risks include:

- spontaneous formation of "tin whiskers" from pure tin (Sn) finishes,
- reduced solder joint integrity,
- reduced reliability due to incompatibility between pieces manufactured from different alloys,
- reduced service life due to the higher temperatures required to manufacture lead-free components.

There are also risks associated with repair activities due to the incompatibility between lead-free and SnPb alloys. The repair procedures and materials for lead-free alternatives are not the same as for traditional SnPb. Mixing SnPb and lead-free repair methods and/or materials can result in flawed solder joints. Care needs to be exercised to ensure that the repair methods and materials are appropriate for the specific technology. However, differentiating between SnPb and lead-free components can be difficult.

Finally, suitable methods for assessing the reliability of lead-free components in the operational environments typical of aviation are not yet available. Traditional test methods and qualification tests have not been proven to be appropriate for use with lead-free components. Industry also lacks suitable thermal cycling testing as well as vibration/shock models.

In 2004, shared concerns regarding the impact of lead-free technology on aerospace electronics prompted the formation of the lead-free Electronics in Aerospace Project Working Group (LEAP-WG). This group was jointly sponsored by the Aerospace Industries Association (AIA), Avionics Maintenance Conference (AMC), and the Government Electronics and Information Technology Association (GEIA). Three standards and three handbooks have been issued by GEIA (Cf. references section 1.2 above).

The LEAP-WG and the US Department of Defense's Executive Lead-Free IPT (Integrated Process Team) have now evolved into the Lead-free Electronics Risk Management (PERM) Consortium to provide a more formal organization to meet the needs of an expanding membership and a growing number of tasks. Additionally, PERM seeks to establish a more effective and coordinated interface with government and industry leaders for the purpose of developing, promulgating and implementing sound lead-free policies.

3. EASA CERTIFICATION GUIDANCE

3.1. EASA GUIDANCE

The intent of this EASA Certification Memorandum is to:

- make applicants aware of the need to assess the impact of the transition to lead-free electronics on the airworthiness of airborne systems and, if necessary, to implement appropriate mitigation, and
- to provide guidance for demonstrating compliance with all the applicable requirements.

The assessment should be accomplished by the development of a Lead-Free Control Plan (LFCP). The standards and handbooks produced by the Government Electronics and Information Technology Association (GEIA) (i.e., GEIA-STD-0005-1 and -2, along with the supporting references) provide one basis for developing a plan and mitigation strategy. However, applicants may propose an alternate strategy for review and acceptance by EASA.

At the present time, the following certification requirements are identified to be impacted by the transition to lead-free electronics and should therefore be specifically addressed:

- Compliance with CS 2X.1301/2X.1309/2x.1431(a): environmental qualification may be impacted by lead-free. Therefore, it should be demonstrated that compliance is maintained/achieved when using lead-free processes:
    - the appropriate tests have been conducted to validate the design choices made during the transition to lead-free, and
    - the design choices made during the transition to lead-free have not invalidated the environmental qualification tests results. This may require repeating some of the original environmental qualification tests.
- Compliance with CS 2X.1309: reliability of electronic parts may be impacted by the use of lead-free electronics. Therefore, previously accepted calculations of probabilities may not be valid anymore and should be re-evaluated.
- Compliance with CS 2X.1529: problems that can arise from intermixing SnPb and lead-free technologies should be taken into account.

Any other potential impact on compliance with airworthiness requirements should be evaluated and addressed.

Applicants should provide, as a minimum:

- A Lead-Free Control Plan (LFCP) which addresses the following:
    - Reliability - The processes and materials that use lead-free solder and finishes are demonstrated to be capable of meeting the reliability requirements.
    - Configuration control and product identification - The configurations of all systems, equipment, assemblies, sub-assemblies, and piece parts are identified and controlled.
    - Risks and limitations– Any risks and/or limitation of use due to the use of lead-free solders and finishes, are identified, and information is provided to control them.

- Tin whiskers - The deleterious effects of tin whiskers are mitigated.
- Repair, rework, maintenance, and support - Repair, rework, maintenance, and support activities are controlled in a manner that controls negative effects of lead-free solder materials and processes.

- A detailed accounting and status of the TC/Change/STC design with respect to lead-free parts and components (i.e., Part Numbers).
- Appropriate maintenance procedures addressing the incompatibility of SnPb and lead-free technologies. Clear instructions on which process should be used for the repair action per board should be available.
- A strategy for monitoring field data (e.g., MTBF) for level A and B equipment. The data should be collected and monitored to ensure that the reliability assumptions used in the design are maintained. Where reliability appears to be reduced, the Agency should be informed and appropriate mitigation should be taken.

3.2. WHO IS AFFECTED BY THIS CERTIFICATION MEMORANDUM

The technical issues associated with the use of lead-free electronics are applicable to all products using electronics, therefore, this Certification Memorandum is applicable to any initial airworthiness project (Type Certificate, change to Type Certificate, or Supplemental Type Certificate) that needs to show compliance with the requirements described above (see Section 1.2).

While a Certification Memorandum is typically addressed within the context of individual projects, the lead-free issue affects all active and planned applications of a design organisation. Therefore, organisations are advised to structure their response to this Certification Memorandum from the company level rather than from within each project to ensure a consistent approach to managing the transition to lead-free.

Furthermore, the applicant's response should focus on those aspects of their designs that have been identified as having significant safety effects if they were to fail. This determination should result from the system safety analysis.

4. REMARKS

1. This EASA Proposed Certification Memorandum will be closed for public consultation on the **31st of March 2014**. Comments received after the indicated closing date for consultation might not be taken into account.
2. Comments regarding this EASA Proposed Certification Memorandum should be referred to the Certification Policy and Planning Department, Certification Directorate, EASA. E-mail CM@easa.europa.eu or fax +49 (0)221 89990 4459.
3. For any question concerning the technical content of this EASA Proposed Certification Memorandum, please contact:

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