



TECHNICAL REPORT

GEIA-HB-0005-1™

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Superseding GEIA-HB-0005-1

(R) Program Management/Systems Engineering Guidelines for
Managing the Transition to Lead-Free Electronics

RATIONALE

This handbook is intended to provide guidance for the mitigation of all potential issues and risks affecting the Aerospace Defense and High Performance (ADHP) electronics industry as a result of the transition from tin-lead (SnPb) to lead-free (Pb-free) electronics. The guidance in this handbook has been developed to assist managers in the responsible mitigation of the impact of the Pb-free electronics transition.

The original release of this document was written primarily from the perspective of a military program. Revision A broadens the perspective, and is rewritten to advise and assist the four primary stakeholders; Systems Engineering, Supply Chain Management, Quality Assurance Management and Program Management.

FOREWORD

The imposition of Pb-free materials is one of the most disruptive events in the ADHP electronics industry in the last 30 years. The transition to Pb-free electronics has far reaching implications on reliability, life, producibility and life cycle cost for ADHP products.

In 2004 the Aerospace Industries Association (AIA), the Avionics Maintenance Conference (AMC), and TechAmerica formed a joint working group with the express purpose of generating a series of industry standards and handbooks to assist in managing the risks associated with the transition to Pb-free solder and Pb-free-finished components and printed wiring boards in ADHP electronic systems. This handbook was prepared by a successor to that group.

This document is intended to be used in concert with GEIA-STD-0005-1, GEIA-STD-0005-2, GEIA-STD-0005-3, GEIA-HB-0005-2 and GEIA-HB-0005-3.

It should be noted that suppliers who have implemented lead-free control plans that are in compliance with GEIA-STD-0005-1 Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder and GEIA-STD-0005-2 Standard for Mitigating the Risks of Tin in High-Reliability Electronic Systems and utilizing GEIA-HB-0005-2 Technical Guidelines for Using Lead-free Solder in Aerospace Applications will have adequately addressed the concerns and issues delineated in sections 3 through 13 of this handbook.

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INTRODUCTION

The European Union (EU) has enacted a directive; 2002/95/EC Restriction of the use of certain Hazardous Substances (RoHS) that restricts or eliminates the use of various substances in a variety of products that are produced after July 2006.

It was revised and reissued as Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment in June, 2011. One of the key materials restricted is lead (Pb), which is widely used in electronic solder and electronic component terminations. While this regulation may appear to only affect products for sale in the EU, due to the reduced market share of the ADHP electronics industry, many of the lower tier suppliers have changed 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.

Pb-free materials and processes are relatively immature. The ADHP electronics industry is one of the few major industrial sectors that still repair Printed Board Assemblies (PBAs); and the performance of Pb-free materials are not fully understood in harsh environments. As such, a standard ADHP industry-wide approach to the transition is deemed to be highly valuable.

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1.	SCOPE	

This handbook is designed to assist a program in assuring the performance, reliability, airworthiness, safety, and certifiability of product(s), in accordance with GEIA-STD-0005-1, “Performance Standard for Aerospace and High Performance Electronic Systems Containing Pb-free Solder”. Please note that the program manager, and managers of systems engineering, Supply Chain and Quality Assurance (along with their respective organizations), and the appropriate enterprise authority need to work together in ensuring that all impacts of Pb-free technology insertion are understood and risks mitigated accordingly. Herein “program management (or manager), supplier chain management (or manager), quality assurance management (or manager) and systems engineering management (or manager) and/or the appropriate enterprise authority” shall be defined as “responsible manager” throughout the remaining document (see Section 3, Terms and Definitions).

The basic principles delineated in this handbook can be used for program management, system engineering, supply chain management and quality assurance management of any aerospace and/or high performance program. Appendix A contains a General Responsible Manager Checklist for Dealing with Pb-free Issues. The checklist can be used to identify potential issues related to the content in sections 5 through 15 of this handbook.

Pb-free technology can impact any program regardless of whether the program itself is exempt or bound by environmental regulations. The industry conversion to Pb-free solder technology may affect manufacturers and consumers of ADHP electronics in one or combinations of the following three ways: (1) If the program is required to implement Pb-free technology (contract requirement, environmental regulation, etc), then the managers of organizations responsible for program execution will need to assess the impact of in-house transition with respect to design (e.g., performance of products using Pb-free) and process (e.g., processes to build Pb-free products). (2) If the program purchases COTS (Commercial-off-the-Shelf) items for its products/systems, then there is a very good chance that these items will contain Pb-free solder or Pb-free finishes on parts, PWBs, or PBAs. (3) Manufacturers of ADHP electronics may inadvertently introduce Pb-free parts or assemblies (including component finish, Printed Wiring Board (PWB) finish, or assembly solder) if careful coordination between buyer and supplier is not exercised.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

GEIA-STD-0005-1	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
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 Electronic Interconnects Containing Pb-Free Solder and Finishes
GEIA-HB-0005-2	Technical Guidelines for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
GEIA-HB-0005-3	Rework/Repair Handbook to Address the Implication of Lead-Free Electronics and Mixed Assemblies in Aerospace and High Performance Electronic Systems
GEIA-STD-0006	Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts
SAE AS9100	Quality Systems – Aerospace - Model For Quality Assurance In Design, Development, Production, Installation And Servicing

2.2 Industry Standards

IEC/TS 62239-1	Process Management for Avionics - Management Plan - Part 1: Preparation and Maintenance of an Electronic Components Management Plan
IEC/TS 62647-1	Process management for avionics - Aerospace and defence electronic systems containing lead-free solder - Part 1: Preparation for a lead-free control plan. This document is the IEC equivalent to the GEIA-STD-0005-1
IEC/TS 62647-2	Process management for avionics - Aerospace and defence electronic systems containing lead-free solder - Part 2: Mitigation of deleterious effects of tin. This document is the IEC equivalent to the GEIA-STD-0005-2
IEC/TS 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. This document is the IEC equivalent to the GEIA-STD-0005-3
IEC/PAS 62647-22	Process management for avionics - Aerospace and defence electronic systems containing lead-free solder - Part 22: Technical guidelines. This document is the IEC equivalent to the GEIA-HB-0005-2
IEC/PAS 62647-23	Process management for avionics - Aerospace and defence electronic systems containing lead-free solder - Part 23: Rework and repair guidance to address the implications of lead-free electronics and mixed assemblies. This document is the IEC equivalent to the GEIA-HB-0005-3

EIA-632	Process for Engineering a System
EIA-731	Systems Engineering Capability Model
EIA-933	Standard for Preparing a COTS Assembly Management Plan
EIA-4899	Standard for Preparing an Electronic Components Management Plan
ANSI/ASQC Q9000	Quality Management and Quality Assurance Standards
ARINC Project 671	Guidance for Lead-Free Soldering, Repair and Rework

2.3 Government Documents

FM 770-78	Army Field Manual, System Engineering
MARCORSYSCOM Order, SPAWARINST 5000.1, NAVFACINST 5000.15 5400.5, NAVSUPINST 5000.21, NAVSEAINST 5000.9, NAVAIRINST 5000.24	

Naval Systems Engineering Technical Review Handbook, Version 1.0

RoHS Directive	DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 July 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (commonly known as the RoHS (Restriction of Hazardous Substances) Directive).
WEEE Directive	DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 August 2012 on waste electrical and electronic equipment (WEEE)

Executive Order 13148 Greening the Government Through Leadership in Environmental Management

2.4 General References

Blanchard, B. S., Fabrycky, W. J., "Systems engineering and analysis", 2 edition, Prentice Hall, New Jersey, 1990.

2.5 Terms and Definitions

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

ASSEMBLIES - Are electronic items that require electrical attachments, including soldering of wires or component terminations; examples include circuit card assemblies and wire harnesses.

COTS (Commercial-Off-The-Shelf) - One or more pieces, mechanical or electrical, developed for multiple commercial consumers, whose design and/or configuration is controlled by the supplier's specification or an industry standard. They can include components, subassemblies, or top level assemblies.

CRITICAL ITEM OR FUNCTION - If defective will result in the system's inability to retain operational capability, meet primary objective, or affect safety.

CUSTOMER - Refers to an entity or organization that (a) integrates a component, 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.

HIGH PERFORMANCE SYSTEM OR PRODUCT - Requires continued performance or performance on demand, or equipment down time 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.

Pb-FREE - Is defined as less than 0.1% by weight of lead in accordance with Waste Electrical and Electronic Equipment (WEEE) guidelines

Pb-FREE CONTROL PLAN (LFCP) - Refers to an aerospace or military system supplier's document that defines the processes that assure the Plan Owners, their customers, and all other stakeholders that aerospace, defense and high performance high-reliability electronics systems containing Pb-free solder and Pb-free component and PB finishes will continue to be reliable, safe, producible, affordable, and supportable.

NOTE: An acceptable LFCP, per GEIA-STD-0005-1, will fulfill all intentions of the standard. ANSI/ASQC Q9000 documentation may provide a strong basis for the control plan.

MAY - Indicates a course of action that is permissible within the limits of this handbook, but not required.

PARTS, MATERIALS AND PROCESSES (PMP) - Includes the disciplines that assure proper application of parts, materials, and assembly processes to produce an item that meets system requirements.

Pb-FREE TIN - Is 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 handbook. Many of these alloys have not been assessed for whiskering behavior.

NOTE: That this definition is different than the typical electronic industry definition of Pb-free, based on RoHS. In those cases, the Pb-content is much lower. For the purpose of this document the higher Pb-content is required to reduce the tin whisker risk.

Pb-FREE TIN FINISH - Is defined to be Pb-free tin final finishes or under-plates either external or internal to a device, PB or other hardware. This includes all leads and surfaces, even those coated, encapsulated, or otherwise not exposed. It may include finishes on electrical components, mechanical components, and PBs. 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.

RESPONSIBLE MANAGER - For purposes of this handbook (and this handbook only), refers to program management (or manager), systems engineering management (or manager), supply chain management (or manager), quality assurance management (or manager) and/or the appropriate enterprise authority. The implications are that the program manager and the other cited stakeholders work together in ensuring that all impacts of Pb-free technology insertion are understood and risks mitigated accordingly.

REPAIR - Is the act of restoring the functional capability of a defective article in a manner that precludes compliance of the article with applicable drawings or specifications.

REWORK - Is an 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. Or is the act of reprocessing non-complying articles, through the use of original or equivalent processing in a manner that ensures full compliance of the article with applicable drawings or specifications.

SHOULD - Indicates that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is discouraged but not prohibited.

SUB-CONTRACTOR - Refers to an 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.

SUPPLIER - Refers to an entity or organization that designs, manufactures, repairs, or maintains a component, unit, or system. For example, this includes original equipment manufacturers (OEMs), repair facilities, subcontractors, and component manufacturers.

SYSTEM - Is defined as one or more units that perform electrical function(s).