IEC/PAS 62647-21

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PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

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

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

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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

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IEC-PAS 62647-21 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**
107/130/PAS	107/138A/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 shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document, or shall be withdrawn.

This PAS is based on GEIA-HB-0005-1 and is published as a double logo PAS. GEIA, Government Electronics and Information Technology Association, has been transformed into TechAmerica Association.

This document is intended to be used in concert with IEC/PAS 62647-1 (GEIA-STD-0005-1) and IEC/PAS 62647-2 (GEIA-STD-0005-2).

It should be noted that suppliers who have been qualified in compliance with IEC/PAS 62647-1 (GEIA-STD-0005-1) and IEC/PAS 62647-2 (GEIA-STD-0005-2) and utilizing IEC/PAS 62647-22 (GEIA-HB-0005-2) will have adequately addressed the concerns and issues delineated in Clauses 5 through 14 of this PAS.

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 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. 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 will change 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.

Since the aerospace industry is one of the few major industrial sectors that still repair Circuit Card Assemblies (CCAs) and since Pb-free materials and processes are relatively immature and poorly understood, an aerospace-wide approach to the transition was deemed to be highly valuable.

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

1 Scope

This PAS is designed to assist program management and/or systems engineering management in managing the transition to lead-free (Pb-free) electronics to assure product reliability and performance.

Programs may inadvertently introduce Pb-free elements (including piece part finish, printed wiring board (PWB) or printed circuit board (PCB) finish, or assembly solder) if careful coordination between buyer and Supplier is not exercised. For example, piece part manufacturers may not always change part numbers to identify Pb-free finishes, especially if the previous tin-lead (Sn/Pb) finished piece part has been discontinued. Detailed examination of piece parts and documents at receiving inspection while crucial may not be sufficient to identify Pb-free piece parts.

NOTE 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 an aerospace program in one or both of the following ways:

1) if the program is required to implement Pb-free technology (contract requirement, environmental regulation, etc), then the Program Manager/lead systems engineer will need to assess the impact of in-house transition with respect to design (performance of products using Pb-free) and process (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, printed wiring boards (PWBs), printed circuit boards (PCB), or circuit cards assemblies (CCA).

The basic principles delineated in this PAS can be used for program management and/or systems engineering management of any aerospace and/or high performance program. The annexes in the PAS describe tools that can be used in conjunction with this handbook.

1) Annex A describes a matrix of product tier level versus associated risks with respect to a Pb-free transition.
2) Annex B contains links to the European Union Directives and Executive Order 13148.
3) Annex C contains a General Program Manager Checklist for Dealing with Pb-free Issues that summarizes the content of this document.
4) Annex D contains a General Manufacturing Process Assessment Checklist to assess Supplier compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1).
5) Annex E describes recommended program language to assure performance, reliability, airworthiness, safety, and certifiability of Pb-free product(s).

This PAS is designed to assist a program in assuring the performance, reliability, airworthiness, safety, and certifiability of product(s), in accordance with IEC/PAS 62647-1 (GEIA-STD-0005-1). Please note that the Program Manager and systems engineer (along with their respective organizations), and the appropriate enterprise authority work together in ensuring that all impacts of Pb-free technology insertion are understood and risks mitigated accordingly. Herein “Program Management (or Manager) and/or Systems Engineering Management (or Manager) and/or the appropriate enterprise authority” shall be defined as “Program Manager” throughout the remaining document (see Clause 3, Terms and Definitions).

2 Normative references

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

Industry Standards

IEC/PAS 62647-1, (GEIA-STD-0005-1),	*Process management for avionics – Aerospace and defence electronics systems containing lead free solder – Part 1: Lead-free management*
IEC/PAS 62647-2 (GEIA-STD-0005-2),	*Process management for avionics – Aerospace and defence electronics systems containing lead-free solder – Part 2: Mitigation of the deleterious effects of tin*
GEIA-STD-0005-1,	*Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder*
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*
IPC-A-610,	*Acceptability of Electronic Assemblies*
AS/EN/JISQ9100,	*Quality Systems – Aerospace – Model For Quality Assurance In Design, Development, Production, Installation And Servicing*
ANSI/ASQC Q9000 ARINC Project Paper 671	*Quality Management and Quality Assurance Standards Guidance for Lead-Free Soldering, Repair and Rework*

3 Terms and definitions

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

3.1
assemblies
are electronic items that require electrical attachments, including soldering of wires or piece part terminations; examples include circuit card assemblies and wire harnesses.

3.2
COTS
is defined as “commercial off the shelf”. It can apply to a piece part, assembly, or unit.

3.3
critical
item or function, if defective, will result in the system’s inability to retain operational capability, meet primary objective, or affect safety.

3.4
customer
refers to an 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.

3.5
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

3.6
lead-free
is defined as less than 0,1 % by weight of lead in accordance with Waste Electrical and Electronic Equipment (WEEE) guidelines

3.7
Lead-free Control Plan (LFCP)
refers to an aerospace or defence system Supplier’s document that defines the processes that assure the plan owners, their Customers, and all other stakeholders that aerospace and high performance high-reliability electronics systems containing Pb-free solder will continue to be reliable, safe, producible, affordable, and supportable. An acceptable LFCP, per IEC/PAS 62647-1 (GEIA-STD-0005-1), will fulfill all intentions of the standard. ANSI/ASQC Q9000 documentation may provide a strong basis for the control plan. Technical guidance on evaluating an adequate LFCP can be found in IEC/PAS 62647-1 (GEIA-STD-0005-1).

3.8
may
indicates a course of action that is permissible within the limits of this PAS, but not required.

3.9
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.

3.10
Pb-free tin finish
is defined to be Pb-free tin final finish or under-plate either external or internal to a piece part, printed wiring board (PWB), printed circuit board (PCB), circuit card assembly (CCA) 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 printed wiring boards (PWB) printed circuit board (PCB) or circuit card assembly (CCA). It does not include Pb-free bulk solders, assembly materials, ball-grid-array terminations, or those devices where the Pb-free tin finish has been completely replaced.

3.11
PCB
stands for Printed Circuit Board, which is also commonly referred to as a Printed Wiring Board (PWB)

3.12
piece part
is defined as an electronic component that is not normally disassembled without destruction and is normally attached to a printed wiring board (PWB), printed circuit board (PCB) or circuit card assembly (CCA), to perform an electrical function

3.13
program manager
for purposes of this PAS (and this PAS only), refers to program management (or manager) and/or systems engineering management (or manager) and/or the appropriate enterprise authority. The reason for this is to streamline this PAS. The implications are that the program manager and systems engineer (along with their respective organizations) and the appropriate enterprise authority work together in ensuring that all impacts of Pb-free technology insertion are understood and risks mitigated accordingly.

3.14
PWB
stands for Printed Wiring Board, which is also commonly referred to as a Printed Circuit Board (PCB)

3.15
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.

3.16
rework
is 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

3.17
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.

3.18
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

3.19
supplier
refers to an 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.

3.20
system
is defined as one or more units that perform electrical function(s).

3.21
tin whisker
is a 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. See IEC/PAS 62647-2 (GEIA-STD-0005-2) for further description of tin whiskers and their physical attributes.

3.22
unit
is defined as one or more assemblies within a chassis to perform electrical function(s)

4 Symbols and abbreviated terms

ATP	Acceptance Test Procedure
CCA	Circuit Card Assembly
COTS	Commercial Off-The-Shelf
ENIG	Electroless Nickel/Gold
EU	European Union
FMECA	Failure Mode Effects and Criticality Analysis
GEIA	Government Electronics and Information Technology Association
IR	Infra-Red
LFCP	Lead-Free Control Plan
OEM	Original Equipment Manufacturer
OSP	Organic Solderability Preservative
Pb-free	Lead-Free
PMP	Parts, Materials, and Processes
PWB	Printed Wiring Board
PCB	Printed Circuit Board
RoHS	2002/95/EC Restriction of Hazardous Substances
SEMP	System Engineering Management Plan
SnPb	Tin/Lead (normally 63 % tin / 37 % lead)
WEEE	2002/96/EC Waste Electrical and Electronic Equipment

5 General discussion of program management/systems engineering management concerns

A Program Manager's role is to be aware of how changes will affect the program, whether the program is on the system level, unit level, assembly level, or piece part level. The change from SnPb solder to Pb-free solder will affect all electronics programs, regardless of level or size. The Program Manager also needs to understand where Pb-free is being introduced in the program (piece part finishes only, assembly soldering, etc.) Annex A differentiates the

various tier levels and the associated risk to consider. The following concerns need to be considered for a successful transition.

5.1 Concerns in accordance to IEC/PAS 62647-1 (GEIA-STD-0005-1)

In accordance with IEC/PAS 62647-1 (GEIA-STD-005-1), program concerns include reliability, configuration control, risk management, effects of tin in the system, and rework/repair and maintenance.

5.1.1 Reliability

The program manager should understand how the transition to Pb-free may affect the reliability of the program. The program manager or a designee should understand the effects of mixing SnPb and Pb-free solder, effects on package types/geometry, how Pb-free may react to the program's use environment, if units and/or systems will include SnPb and Pb-free assemblies, piece parts, etc. In addition, the Program Manager should consider a common reliability data collection during all phases of the program to facilitate systems performance improvement.

5.1.2 Configuration control

The need for configuration control is paramount to the Pb-free transition. Studies have shown that mixing SnPb and Pb-free solders or the mixing of Pb-free solders of different alloys and/or piece parts (solders or finishes of different alloys) may have detrimental impact on the long-term reliability under high stress (e.g., military, commercial aerospace, or space) environments. The program manager should understand the appropriate configuration controls (e.g., traceability) that are necessary for the program's environment. Note, the program manager must decide the configuration control measures that must be taken for the various levels (i.e., piece part, assembly, unit, system).

The material content of the terminations (component leads) is critical in assuring adequate reliability and performance of finished product. The program manager should ensure that appropriate and demonstrated processes are in place at suppliers that will accurately identify the material content of piece parts used in soldered assemblies and that the material content is compatible with the supplier's soldering processes.

The program manager may require a parts, materials, and processes plan to be in place at the supplier which reflects appropriate quality control procedures. the plan should include sub-contractor controls that affect the reliability of the end product.

5.1.3 Risk management

Risk identification and risk assessment need to be performed for the Pb-free transition for the particular environmental conditions of the program. Risks need to be identified early and a mitigation strategy engaged. The Program Manager has a responsibility to conduct a complete risk management plan.

5.1.4 Detrimental effects of tin

Pb-free tin finishes in an avionics or high performance system can have detrimental effects to functionality of the system as tin whiskers can spontaneously grow from the surfaces. Piece parts with Pb-free tin finishes have already been introduced into aerospace and high performance systems with minimal understanding of the effects that it will have. Program Managers need to have a plan for either eliminating use of Pb-free tin in their product, through life-time buys or re-finishing piece parts, or a plan for addressing and mitigating the risks.

IEC/PAS 62647-2 (GEIA-STD-0005-2) provides standard methods for controlling and mitigating the use of Pb-free tin finished piece parts. It defines three basic levels, with

additional sublevels, for controlling and mitigating the use of Pb-free tin finishes with accurate regard to tin whiskers. These levels can be summarized as follows.

Level 1. No restrictions on Pb-free tin finish use.

Level 2. Pb-free tin finish is allowed under some circumstances.

- ***Level 2A.*** Use of Pb-free tin finish without explicit controls is acceptable under most circumstances but the likelihood of whiskers and methods used to estimate their impact and mitigation strategies will be documented. Pb-free tin finish may be prohibited in some specific circumstances called out in contractual documents.
- ***Level 2B***. Pb-free tin finishes may be used but only with Customer approved and specified control measures. These Pb-free tin finish approvals may be blanket approvals for multiple piece parts and applications within the system. Pb-free tin finish may be prohibited in some specific circumstances called out in contractual documents.
- ***Level 2C***. Restricted use of Pb-free tin finish. Pb-free tin finish is prohibited unless an exception with Customer approval is made. Specific instruction on use of Pb-free tin finish and required control measures to be provided and reviewed on a case-by-case basis.

Level 3. Use of Pb-free tin finish is prohibited and measures must be taken to verify compliance.

These levels are designed to be used in requests for proposals and control documents. The Customer should determine the appropriate control level or levels for their product, based on criticality, their comfort with the risk, and other mitigating features of their program, such as redundancy and repairability. For many larger programs, different subsystems or units may need different control levels that can be based on Customer and Supplier discussions and agreement regarding both application and Supplier mitigation solution knowledge.

In most cases, it would be appropriate for OEMs to have general policies that aid in the selection of the appropriate control level. Program Managers should work with their companies to develop the policy to aid in consistent requirements across programs.

Program Managers also need to be prepared for handling errors in finish determination or mitigation application. This may simply be a variation in the program's normal process waiver process or may require a more in-depth risk assessment, depending on the criticality level.

5.1.5 Rework/repair and maintenance

Rework/repair and maintenance becomes a concern if SnPb and Pb-free solders and/or piece parts are used on the same assemblies. As stated before, studies have shown that reliability of the joints/junctions of mixed lead and Pb-free solder may decrease in high stress environments. A Program Manager should make the Customer aware of the higher risks associated with field rework/repair and maintenance when standard solder materials (i.e. 60 % tin/40 % lead or 63 % tin/37 % lead) are used on Pb-free assemblies and/or piece parts.

5.2 Additional program management / system engineering concerns

The Program Manager also has additional concerns from a programmatic point of view. These include cost, parts obsolescence, COTS, quality, contract language, other existing program constraints, updating of the program System Engineering Management Plan (SEMP). Other concerns can be addressed based on specific program needs.

5.2.1 Cost

The costs of the Pb-free transition need to be quantified and decisions need to be made as to who will assume the costs. The Program Manager should be aware that the situation is likely to be dynamic over the next several years. Added costs may come from additional risk

management determination, configuration controls, rework/repair and maintenance changes, drawing changes, possible redesign, re-qualifying/delta qualifying, etc.

5.2.2 Commercial off-the-shelf

Commercial-off-the-shelf (COTS) is always a critical concern for a Program Manager. The very nature of COTS may allow Pb-free substitution irrespective of program requirements.

5.2.2.1 COTS piece parts and parts obsolescence or COTS piece parts

The Supplier may request substitution of Pb-free finished piece parts on a program. This occurs not only because of the piece part Supplier obsolescing standard SnPb-finishes, but also due to a COTS piece part substitution. The Program Manager or a designee should have controls in place and understand IEC/PAS 62647-2 (GEIA-STD-0005-2), to mitigate the risks associated with Pb-free finished piece parts and COTS. The Program Manager needs to ensure that the parts, materials, and processes (PMP) control plan for the program is updated and addresses how lead-free piece parts will be identified and tracked. If a PMP control plan is not available for the program, the Program Manager should ensure that the PMP functional group is aware of each parts substitution and is adequately addressing the issue of lead-free piece parts.

5.2.2.2 COTS assemblies

The product may contain COTS assemblies, as well. The Program Manager should be aware of the possible risks due to COTS assemblies containing either Pb-free piece parts and/or Pb-free soldered assemblies. The Program Manager needs to ensure that the parts, materials, and processes (PMP) control plan for the program is updated and addresses how lead-free assemblies will be identified and tracked. If a PMP control plan is not available for the program, the Program Manager should ensure that the PMP functional group is aware of each parts substitution and is adequately addressing the issue of lead-free assemblies.

5.2.3 Quality

Quality is a critical consideration in the transition to Pb-free and the Program Manager needs to be assured that the final product meets the technical and operational requirements with the specified reliability at all levels (reference IPC-A-610 and/or AS/EN/JISQ9100 depending on the program requirements). This includes flow of requirements, implementation and documentation through and to subcontractors.

5.2.4 Contractual language

Appropriate contractual language needs to be included in new contracts that describe the Customer requirements regarding Pb-free parts. Example contractual language is included in Annex E.

5.2.5 Program constraints

The Program Manager needs to be proactive in understanding all of the impacts to the program schedule (including all integrated master schedule line items). Consideration needs to be particularly paid to changes in the delivery schedule due to requalification/delta qualification of Pb-free parts and additional reliability testing. Also, if risk mitigation plans include lifetime buys of long-lead SnPb-finish parts (due to obsolescence), the updated schedule needs to reflect the changes appropriately.

5.2.6 System engineering management plan

The Program Manager should reassess the program's system engineering management plan, if one exists, and update to include the Pb-free transition controls for the program.

6 Requirements definition

A re-evaluation of the program requirements should be performed to determine the impact of the Pb-free transition.

6.1 Customer requirements

The Program Manager should include all of the Pb-free transitions in a thorough risk assessment/mitigation plan and present it to the Customer. The purpose of the plan is to help the Customer understand the risks associated with the transition.

6.1.1 WEEE and RoHS Directives

The Program Manager should understand the implications of the WEEE and RoHS directives (Annex B).

6.1.2 Executive Order 13148 (green initiative)

Even though this generally applies only to facility operations issues, weapon system maintenance by the Customer may come under this category. The Program Manager should be aware of the Customer's requirements in this area (Annex B).

6.2 Additional prime contractor requirements

Additional prime contractor requirements need to be re-assessed with regard to a possible Pb-free transition.

6.3 Change control

The Program Manager should determine if any change from SnPb to Pb-free constitutes a change for which Customer approval is needed. The purpose is to assure that configuration control, traceability, and marking are properly controlled.

7 Use environment(s)

7.1 Impact on use environment(s)

The use environment(s) is defined by the program requirements. The Program Manager needs assurance from the Supplier that the transition from SnPb to Pb-free solder will not impact reliability of the product in the use environment. The consideration here is whether or not Pb-free solder will behave differently than SnPb solder in the use environment.

7.2 Impact on storage and transport

The Program Manager or a designee should evaluate the storage and transport requirements with respect to any Pb-free implementation. The impact of SnPb versus Pb-free solder on long-term storage or transport environment could be significant and needs to be evaluated as part of the risk management plan.

8 Decision criteria

8.1 Program decision concerning Pb-free

The Program Manager must choose whether or not any Pb-free will be accepted. This decision should be based on Customer feedback, risk analyses, system engineering analyses, and Supplier information. Annex C describes a checklist for the Program Manager to use for ascertaining the effects of a Pb-free transition to the program.

8.2 Compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1)

The Program Manager or a designee should require a Supplier to show compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1). Annex D describes a checklist for a program to use to determine a Supplier's compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1).

8.3 Solder alloy chosen

The Program Manager or a designee should request a summary of the data that the Supplier's decision was based on for making the transition to Pb-free. It should summarize the results of the Supplier's studies and may include results from internal research and development, external test results and studies, trade studies, reliability/durability tests, FMECA (Failure Mode Effects and Criticality Analysis), manufacturing infrastructure to segregate solder, processes, and materials, manufacturing capabilities, manufacturing controls, etc.

NOTE The use of Pb-free tin plating (piece part leads, CCAs, etc) can pose some risks due to formation of tin whiskers (reference: IEC/PAS 62647-2 (GEIA-STD-0005-2)). To avoid these risks, high performance programs may prohibit the use of Pb-free tin plating. The Program Manager needs to understand the required reliability levels of the program and, if necessary: (1) implement a plan to prevent acquisition of Pb-free tin plated piece parts or (2) generate a plan to mitigate risk of being forced to acquire Pb-free tin plating (e.g., re-finishing or other approaches).

8.4 Other programs

To understand the Supplier's Pb-free decision, the Program Manager or designee may request the Supplier to give additional information.

8.4.1 Percentages of product

The Program Manager may want to request information from the Supplier about what percentage of their deliverable products are being converted to Pb-free. This will help evaluate the maturity of the Supplier's process.

8.4.2 Supplier awareness

The Supplier should have an awareness of what other programs in their industry are requesting or requiring with regard to Pb-free to make sure that their requirements achieve some commonality with other programs.

9 Suppliers lead-free control plan

The Program Manager should consider whether or not to require a lead-free control plan (LFCP) from the Supplier making the Pb-free transition (reference IEC/PAS 62647-1 (GEIA-STD-0005-1)). The following elements (Subclauses 9.1 through 9.5) may be included in such a plan. If the Program Manager does **not** wish to require a formal LFCP from the Supplier, the Supplier should demonstrate, as a minimum, the Supplier's subcontractor control (Subclause 9.1), their manufacturing risk management (Subclause 9.4), and the schedule of Pb-free implementation (Subclause 9.5). The LFCP also needs to be referenced in the program's PMP control plan for complete coordination.

9.1 Supplier procurement & subcontractor control

The Program Manager or designee should request and review the Supplier's procurement and subcontractor control plan to assure that the Supplier is mitigating the risks of the Pb-free transition of its sub-tier Suppliers. Elements of the subcontractor control plan need to include acquisition decisions regarding piece parts, procured printed wiring boards (PWBs), printed circuit boards (PCBs), procured assemblies, and peripheral hardware (including cables, wiring, etc.).

9.1.1 Supplier procurement

The Supplier should have available for review by the Program Manager or designee, a procurement assessment of their sub-tier Suppliers that are transitioning to Pb-free. All risks from sub-tier Suppliers concerning the Pb-free transition should be included in the Supplier's subcontractor control plan.

9.1.2 Supplier subcontractor control plan

The Program Manager or designee should request and review the Supplier's subcontractor control plan to assure that the Supplier is mitigating the risks of the Pb-free transition of its sub-tier Suppliers. Elements of the subcontractor control plan need to include piece parts, procured printed wiring boards (PWBs), printed circuit boards (PCBs), procured assemblies, and peripheral hardware (including cables, wiring, etc.).

9.1.2.1 Procured piece parts

The subcontractor control plan should include piece parts that have been transitioned to Pb-free finishes. Elements should include updates to the program parts obsolescence plan, if available, use of COTS piece parts and data that verifies that piece parts can tolerate Pb-free assembly and repair processes.

9.1.2.2 Procured printed wiring boards (PWBs) & printed circuit boards (PCBs)

The subcontractor control plan should include procured printed wiring boards (PWBs) & printed circuit boards (PCBs) that have transitioned to Pb-free finishes. Elements should include data that verifies that printed wiring boards (PWBs) & printed circuit boards (PCBs) can tolerate Pb-free assembly and repair processes.

9.1.2.3 Procured assemblies

The subcontractor control plan should include procured and build-to-print assemblies and modules that have transitioned to Pb-free soldering. Elements should include data that the Pb-free solder joints meet the program reliability requirements. It should also include Supplier recommendations regarding rework and repair materials and processes.

9.1.2.4 Peripheral hardware

The subcontractor control plan should include procured peripheral hardware, including cables, wiring, etc., that have transitioned to Pb-free soldering. Elements should include data that the Pb-free soldering meets the program reliability requirements. It should also include Supplier recommendations regarding rework and repair materials and processes.

9.2 Productibility plan

The program manager or designee should understand any changes in Supplier productibility that has occurred as a result of the Pb-free transition. This should include identification and plan to control new key characteristics.

9.3 Manufacturing changes

The program manager or designee should understand the process changes that have occurred as a result of the change of solder alloy. This should include both fabrication processes and rework/repair processes. This should also include changes to fabrication equipment (e.g., wave soldering unit, mass reflow unit, hand soldering equipment, cleaning equipment, inspection stations). This should also include how changes to the fabrication processes will be controlled, updates to the process control plan (including statistical process control), and changes to production readiness.

9.4 Manufacturing risk management

The Supplier should identify, assess, and have a mitigation plan for all risks associated with its own Pb-free transition, as well as its sub-tier Suppliers. This information should be given to the program manager or designee in a timely manner. The program manager should understand the added manufacturing risks and update the program risk management plan appropriately. As a minimum, the Supplier identification, assessment, and mitigation that affect end-item reliability, schedule, or cost should be included in the program risk management plan. Also, the Supplier plan for identification of Pb-free products should be included.

9.5 Supplier schedule of Pb-free implementation

The program manager should understand changes to the program schedule that have resulted from Supplier Pb-free transitions. Schedule changes might be impacted due to development of Pb-free processes and controls. Time to adequately address issues during development should be provided.

10 Requalification / test plan

The program manager with customer concurrence should determine if the product that is transitioning with Pb-free solder should be re-qualified, delta qualified, accepted by analysis/test, or accepted by similarity. Delta qualification is a subset of a full qualification, when only the part that has been changed is re-qualified. The decision criteria should be quantified with respect to the associated risks of requalification, delta qualified, acceptance by analysis/test, and acceptance by similarity.

10.1 Delta qualification or requalification

If the decision is to delta qualify or re-qualify the product, the program manager or designee should review the updated qualification plan from the Supplier. This plan should include product to be delta qualified or re-qualified, criteria for acceptance, updated test procedures (including changes to the Acceptance Test Procedure (ATP)), updated schedule and in case of delta qualification the responsible party shall be identified.

10.2 Acceptance by analysis / test

If the decision is to accept the product by analysis/test, the program manager or designee should review the results and validate for applicability to the designated program.

10.3 Acceptance by similarity

If the decision is to accept the product by similarity, the program manager or designee should review the updated qualification plan from the supplier. This plan should include product to be accepted by similarity, rationale for acceptance, criteria for acceptance, and data that supports the decision.

11 Rework / repair and maintenance

The program manager should request rework/repair procedures from the Supplier for Pb-free soldering process. The program manager may also refer to ARINC Project Paper 671 for guidance.

11.1 Supplier recommendations for rework/repair of Pb-free products

The repair procedures from the supplier of rework/repair of Pb-free products should include recommended alloy type, recommended soldering process, recommended cleaning process, and all supporting data. The repair procedures should also include a risk assessment of the use of SnPb solder in the rework/repair of the Pb-free product.

11.2 Maintenance and training documentation

The program manager or a designee should review all maintenance and training documentation for changes in rework/repair procedures. These changes should be communicated prior to delivery of the Pb-free product(s).

12 Risk management

The program manager or a designee should determine the possible additional risks associated with the transition to Pb-free. The program manager or a designee should use the supplier risk management plan(s), if available, to reassess the program-level risk.

12.1 Program-level identification of program-level risks

The program manager or designee should identify all risks associated with the transition to Pb-free in the program risk management plan, including manufacturing risks that have been communicated by the supplier.

12.2 Risk analyses

the program manager or designee should analyze all risks associated with the transition to Pb-free in the program risk management plan, including manufacturing risks that have been communicated by the supplier.

12.3 Risk mitigation

The program manager or designee should mitigate all risks associated with the transition to Pb-free in the program risk management plan, including manufacturing risks that have been communicated by the supplier.

13 Cost

The program manager should conduct a program cost impact analysis with respect to the Pb-free transition. It should include as a minimum, risk management, requalification/delta qualification impact, rework/repair/maintenance impact, warranties, and schedule impact. The cost impact analyses should also include impact to both recurring and non-recurring costs, as well as any cost savings and cost avoidance. Cost savings and/or avoidance may result from using less expensive piece parts. However, the program manager should anticipate additional costs due to possible requalification/delta qualification efforts.

14 Presentation to customer

the program manager should brief the customer on the program-level aspects of the Pb-free transition.

14.1 Compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1)

It should be shown how the Pb-free product complies to IEC/PAS 62647-1 (GEIA-STD-0005-1). Note that an approved lead-free control plan meets the requirements of IEC/PAS 62647-1 (GEIA-STD-0005-1).

14.2 System engineering management plan

The System Engineering Management Plan (SEMP), if applicable, should be updated.

14.3 Other deliverables to the customer

The customer briefing should include the supplier Pb-free implementation plan, updated program risk management plan, configuration control of the Pb-free product, recommended rework/repair procedures, cost impact analyses, performance and/or reliability impact, and the schedule of program implementation of Pb-free.

Annex A
(informative)

Matrix of tier level versus associated risk

Paragraph	Title	Level			
		Piece part	Assembly	Unit	System
5	Program mgmt concerns				
5.1	Concerns in accordance to IEC/PAS 62647-1 (GEIA-STD-0005-1)	X	X	X	X
5.1.1	Reliability	X	X	X	X
5.1.2	Configuration control	X	X	X	X
5.1.3	Risk management		X	X	X
5.1.4	Detrimental effects of tin	X	X	X	X
5.1.5	Rework/repair and maintenance		X	X	X
5.2	Additional program mgmt/sys eng concerns	X	X	X	X
5.2.1	Cost			X	X
5.2.2	Commercial-off-the-shelf	X	X	X	X
5.2.3	Quality	X	X	X	X
5.2.4	Contractual language			X	X
5.2.5	Program constraints			X	X
5.2.6	System engineering management plan			X	X
6	Requirements definition		X	X	X
7	Use environment(s)				
7.1	Impact on use environment(s)	X	X	X	X
7.2	Impact on storage and transport	X	X	X	X
8	Decision criteria				
8.1	Program decision concerning Pb-free				
8.2	Compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1)		X	X	X
8.3	Solder alloy chosen	X	X	X	X
8.4	Other programs			X	X
9	Suppliers lead-free control plan				
9.1	Supplier procurement & subcontractor control		X	X	X
9.1.1	Supplier procurement		X	X	X
9.1.2	Supplier subcontractor control plan		X	X	X
9.1.2.1	Procured piece parts		X	X	
9.1.2.2	Procured printed wiring boards (PWBs) & printed circuit boards (PCBs)		X	X	
9.1.2.3	Procured assemblies			X	X
9.1.2.4	Peripheral hardware			X	X
9.2	Producibility plan		X	X	X
9.3	Manufacturing changes	X	X	X	X
9.4	Manufacturing risk management	X	X	X	X
9.5	Supplier schedule of Pb-free implementation	X	X	X	X

Paragraph	Title	Level			
		Piece part	Assembly	Unit	System
10	Requalification / test plan	X	X	X	X
11	Rework/repair and maintenance		X	X	X
12	Risk management		X	X	X
13	Cost		X	X	X
14	Presentation to customer			X	X

Annex B
(informative)

Links to the European Union Directives and Executive Order 13148

WEEE Directive

Directive 2003/108/EC of the European Parliament and of the Council of 8 December 2003 amending Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) [http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en00240038.pdf]

RoHS Directive

Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 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). The directive bans the use of lead, mercury, cadmium, chromium (VI) and certain bromine – containing materials.
[http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en00190023.pdf]

Executive Order 13148:

Executive Order 13148 of April 21, 2000 – Greening the Government Through Leadership in Environmental Management. The head of each Federal agency is responsible for ensuring that all necessary actions are taken to integrate environmental accountability into agency day-to-day decision making and long-term planning processes, across all agency missions, activities, and functions. Consequently, environmental management considerations must be a fundamental and integral component of Federal Government policies, operations, planning, and management.
[http://ceq.eh.doe.gov/nepa/regs/eos/eo13148.html]

Annex C
(informative)

General program manager checklist for dealing with Pb-free issues

Requirements issues

- ❑ Determine the impact to performance requirements.
- ❑ Reallocate system requirements; determine if this changes the scope of any contracts.
- ❑ Assess impact on reliability of the piece part, assembly, unit and the system.
- ❑ Assess safety issues.
- ❑ Review maintainability requirements and determine the impact on frequency of maintenance.
- ❑ Assess impact on the components of the system that interface with the delivered product.
- ❑ Assess impacts on test equipment and/or test facilities.
- ❑ Determine any required changes in support equipment.
- ❑ Identification of the hardware, piece parts, and shipping containers.
- ❑ Determine any changes to the drawing requirements, solder callouts, process specifications and conformal coatings.

Supplier management issues

- ❑ Determine the availability of alternative suppliers.
- ❑ Determine the feasibility of a lifetime buy of the old part.
- ❑ Controls are in place for screening/receiving Pb-free finishes piece parts.
- ❑ Evaluate supplier's internal delivery schedule for any new parts.
- ❑ Assess relationships of supplier to vendor:
  - ❑ is supplier's vendor new or existing?
  - ❑ if new, can former vendor continue delivering the old part?
- ❑ evaluate risks due to changes of suppliers and vendors
  - ❑ Schedule
  - ❑ Cost
  - ❑ Technical
- ❑ Assess any opportunities for schedule or cost savings.

Schedule issues

- ❑ Evaluate impact on the following:
  - ❑ Critical path
  - ❑ Activities on the near-critical paths
  - ❑ Deliveries to test and evaluation activities
- ❑ Assess schedule impact due to any additional required tests or equipment.
- ❑ Determine and evaluate risks due to any change in schedule.

Cost issues

- ❑ Determine if any cost savings will be shared by the supplier.

- Assess cost impact due to any schedule or technical requirements changes:
  - Supplier costs
  - Internal labor costs
  - Costs of additional testing/qualification (facility, labor, equipment)

Configuration management

- Ensure new part is included in CM documentation.
- Alert other programs within the organization that use the same part.
- Ensure processes are in place to handle field returns and rework or repair of field returns.

Annex D
(informative)

General manufacturing process assessment checklist for assessing supplier compliance to IEC/PAS 62647-1 (GEIA-STD-0005-1)

This tool may be used for assessing a supplier's compliance to the requirements of IEC/PAS 62647-1 (GEIA-STD-0005-1). However, it may also be used to assess a supplier's compliance to the intent of IEC/PAS 62647-1 (GEIA-STD-0005-1), if the supplier is not familiar with the standard.

IEC/PAS 62647-1 (GEIA-STD-0005-1.) VERIFICATION CHECKLIST

(A) Documentation:

	YES	NO	N/A
1. Does the facility recognize IEC/PAS 62647-1 (GEIA-STD-0005-1) for mitigating the risks associated with Pb-free products, processes, and piece parts? If yes, what revision? If not, what is the status of document recognition?	☐	☐	☐
2. Does the facility recognize IEC/PAS 62647-2 (GEIA-STD-0005-2) for mitigating the effects of tin finishes on piece parts? If yes, what revision? If not, what is the status of document recognition?	☐	☐	☐
3. Does the facility have a lead-free control plan based on the requirements of IEC/PAS 62647-1 (GEIA-STD-0005-1)?	☐	☐	☐
4. If not, does the facility have a Pb-free soldering performance plan?	☐	☐	☐
5. Does the documentation that travels with the product during fabrication delineate all uses of Pb-free in the product(s) and processes?	☐	☐	☐
6. Are work instructions adequate so that identified personnel can recognize where Pb-free piece parts and/or processes are introduced?	☐	☐	☐
7. Record which processes the manufacturing facility considers key or critical to Pb-free risk mitigation?	☐	☐	☐

_____

_____

_____

_____

	YES	NO	N/A
8. Does the supplier have procedures that ensure that Pb-free processes meet the drawing requirements? Describe the method(s) that the supplier uses.	☐	☐	☐
_____			
_____			
_____			
_____			
_____			
9. Are certifications/records available indicating that solderability and piece part finishes have been tested?	☐	☐	☐
10. Are the piece parts tested by lot date code? Record the frequency and sampling plan.	☐	☐	☐
_____			
_____			
11. Do procedures require that defects on Pb-free-finished piece parts be specifically documented prior to any rework or repair action?	☐	☐	☐
12. Do maintenance instructions identify critical areas/surfaces that need to be maintained on critical Pb-free process equipment, such as the following:	☐	☐	☐
a) Hot air solder leveler, if applicable?	☐	☐	☐
b) Wave solder unit?	☐	☐	☐
c) Convection, Infra-Red (IR), or convection IR reflow unit?	☐	☐	☐
d) Rework or repair equipment?	☐	☐	☐
e) Other?	☐	☐	☐
13. _____	☐	☐	☐
14. _____	☐	☐	☐

(B) Materials:

(B1) – Material – Piece parts: YES NO N/A

1. Is there established acceptance criteria for piece parts used by the supplier? List the reference document(s). ☐ ☐ ☐

2. What are the finishes of the piece parts used by the supplier:

a) Sn/Pb? Approximate % of production piece parts = _____ ☐ ☐ ☐
b) Tin? Approximate % of production piece parts = _____ ☐ ☐ ☐
c) Gold? Approximate % of production piece parts = _____ ☐ ☐ ☐
d) Pb-free (no specific Pb-free callout) or RoHS-compliant? Approximate % of production piece parts? _____ ☐ ☐ ☐
e) Other? Approximate % of production piece parts = _____ ☐ ☐ ☐

3. Explain how piece parts with Pb-free finishes are controlled * in storage:

a) Sn/Pb? ☐ ☐ ☐
b) Pb-free tin? ☐ ☐ ☐
c) Gold? ☐ ☐ ☐
d) Pb-free (no specific Pb-free callout) or RoHS-compliant? ☐ ☐ ☐
e) Other? ☐ ☐ ☐

* As verified per manufacturer instructions or internal standard process or customer requirement.

4. Explain how piece parts with Pb-free finishes are controlled * on the manufacturing floor (i.e. kitting, soldering processes, assembly):

a) Sn/Pb? ☐ ☐ ☐
b) Pb-free tin? ☐ ☐ ☐
c) Gold? ☐ ☐ ☐
d) Pb-free (no specific Pb-free callout) or RoHS compliant? ☐ ☐ ☐
e) Other? ☐ ☐ ☐

* As verified per manufacturer instructions or internal standard process or customer requirement.

5. Does the supplier re-identify the piece part (neither on the piece part or the packaging or both) if the piece part finish is Pb-free? ☐ ☐ ☐