# *Facilitating NASA's use of GEIA-STD-0005-1, Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder*

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-RoHS Movement in Europe in mid 1990's [a.]

-solderable surfaces and solder itself must be Pb-free

-Worldwide suppliers offer pure tin as alternative

-Researchers and users are reminded of the tin whisker hazard

-Industry searches for new solder formulations

| | | |
|---|---|---|
| $SnAg_{3.0}Cu_{0.5}$ | $SnAg_{3.8}Cu_{0.7}Sb_{0.25}$ | $SnZn_9$ |
| $SnAg_{3.5}Cu_{0.7}$ | $SnAg_{3.8}Cu_{0.7}Sb_{0.25}$ | $SnZn_8Bi_3$ |
| $SnAg_{3.5}Cu_{0.9}$ | $Sn_{3.5}Ag_{0.74}Cu_{0.21}Zn$ | $SnAg_{2.5}Cu_{0.8}Sb_{0.5}$ |
| $SnAg_{3.8}Cu_{0.7}$ | $Sn_{3.5}Ag_{0.85}Cu0_{0.1}Mn$ | $SnIn_{8.0}Ag_{3.5}Bi_{0.5}$ |
| $SnAg_{3.9}Cu_{0.6}$ | $SnCu_{0.7}$ | $SnBi_{57}Ag_1$ |

-New formulations come with known and unknown risks

-Sensitivity to physical shock

-Some test methods do not "translate"

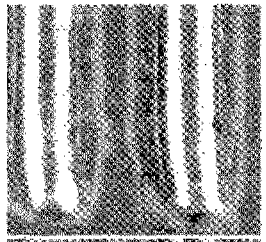
-Higher processing temperatures can affect boards and parts

-Assemblies may mix solders

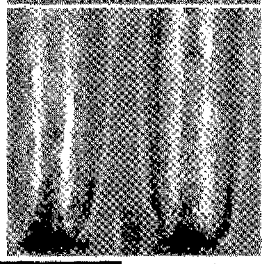
-Logistics may not be set up to identify Pb-free materials

-Solder joints have "dull" appearance

a.

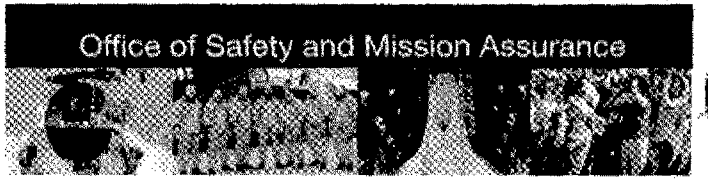


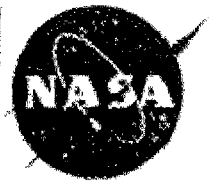
b.



a. *SnPb solder, b. Pb-free solder, Source: Lead Free Surface Mount Technology, Ian Wilding, Henkel Technologies, 2005*







-Industry groups worked to fill void in best-practice standards
  - -Technical basis of emerging standards questioned
  - -New standards did not recognize supply chain issues
  - -Part suppliers starting to advertise "whisker-free" per these standards

-ELF IPT and LEAP WG formed by engineering leaders in DoD Prime Contractor community to focus efforts in research, best practices, and policy. *(NASA begins participation in March 2006)*

Aerospace Industries Association (AIA)-Avionics Maintenance Conference (AMC)-Government Electronics and Information Technology Association (GEIA) Lead-free Electronics in Aerospace Project Working Group (WG)

Examples of projects:

Component re-processing (BGAs, Lead Dipping)
Solder joint reliability characterization
Fundamentals of whisker growth
Mixed alloys systems (original and repaired)
Supply chain requirements flow down
Assembly and part identification and traceability
Training

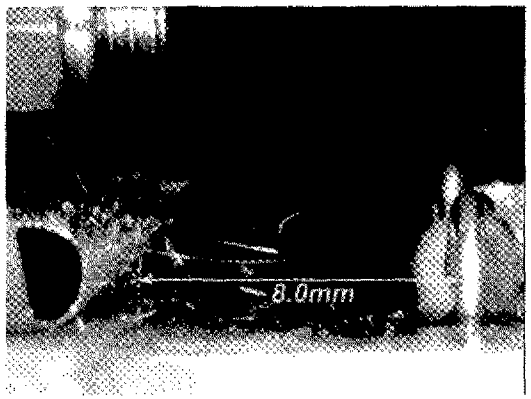



*Photo source: "Tin Whiskers Found on ATVC SN 0034", Don McCorvey, 2006*

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 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

GEIA-HB-0005-4 Impact of Lead-Free Solder on Aerospace Electronic System Reliability and Safety Analysis

# GEIA-STD-0005-1 Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder

- Defines the objectives of, and requirements for, documenting processes that assure customers and regulatory agencies that AHP electronic systems containing Pb-free solder, piece parts, and boards will satisfy the applicable requirements for performance, reliability, airworthiness, safety, and certify-ability throughout the specified life of performance.

- Communicates requirements for a Lead-free Control Plan (LFCP) to assist suppliers in the development of their own Plans. The Plan documents the Plan owner's (supplier's) processes, that assure their customers, and all other stakeholders that the Plan owner's products will continue to meet their requirements.

- This standard does not contain detailed descriptions of the processes to be documented but lists high-level requirements for such processes, and areas of concern to the AHP industries that must be addressed by the processes.

# *Quality Assurance Requirements Traceability*

NPD 8730.2, NASA Parts Policy

Attachment A: Criteria to Mitigate Risks Associated with Lead-Free Solder and Surface Finishes

*(paraphrased)*

a. Sn-Pb shall be used whenever possible. Use of Pb-free (<3% Pb) may be used by special approval on technical need and risk mitigation.

b. A GEIA-STD-0005-1 Pb-free control plan is required which addresses:

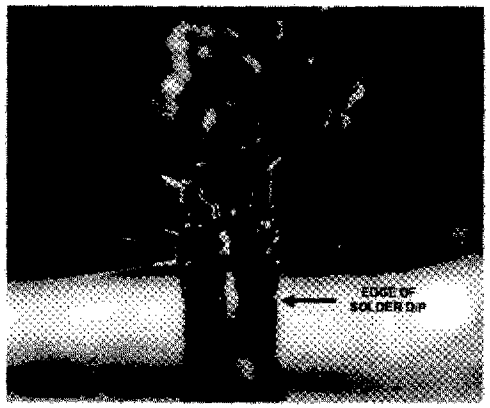
| | |
|---|---|
| *design considerations* | *manufacturing process controls* |
| *test & qualification requirements* | *quality inspection & screening* |
| *marking & identification* | *maintenance & repair* |
| *risk mitigation* | *application uniqueness's* |

c. GEIA-STD-0005-2 "2C" level whisker risk mitigation. "2B" level allowed in special circumstances and with PCB approval.

d. Use of Pb-free Sn-based solders and surface finishes, in applications below 13.2°C, shall be assessed for the risk of the damaging effects of tin pest formation (allotropic phase transformation of tin).

# *Quality Assurance Requirements Traceability*

J-STD-001DS.1 Joint Industry Standard, Space Applications Electronic Hardware Addendum to J-STD-001D Requirements for Soldered Electrical and Electronic Assemblies

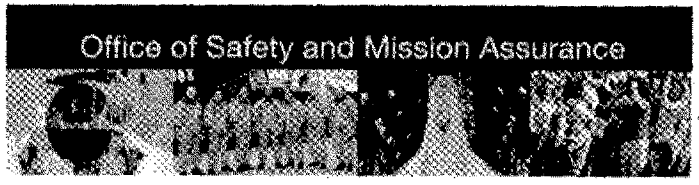



1. Scope is surfaces to be soldered and solder used

2. The following are specifically prohibited without meeting additional requirements:

- Pb-free tin platings or metallization on external surfaces of EEE parts, mechanical parts, including on parts inside of modules (e.g. MCM, Relays)

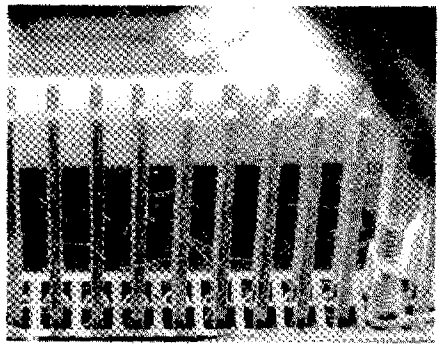
- Pb-free solder alloy except Sn96.2Ag3.7



# *Quality Assurance Requirements Traceability Cont. J-STD-001DS.1*

3. The cases above are allowed only with a USER approved lead-free control plan (LFCP) which accomplishes:
    a. Replating or hot solder dip replacement of Pb-free surfaces with SnPb -or-
    b. Minimum of 2 other risk mitigation methods employed

4. LFCP shall ensure functionality of hardware in <u>intended application</u> w/r/solder, platings, soldering processes
    a. Document every incidence of use
    b. Minimum of two mitigation methods
    c. Document special design requirements, processes, testing, inspections, marking, repair



| # | Document Number | Status | Date | Title |
|---|---|---|---|---|
| 1. | View **TECHAMERICA GEIA-STD-0005-1** Details \| History | **Active** | 06/01/2006 | Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder |

ANSI/GEIA-STD-0005-1
Approved: February, 07 2007

# GEIA STANDARD

GEIA-STD-0005-1

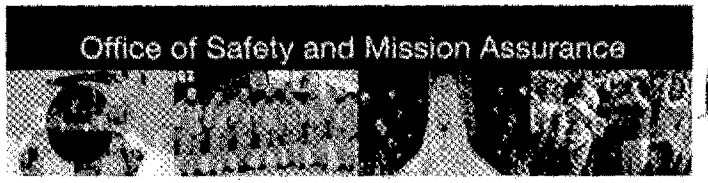
## Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder

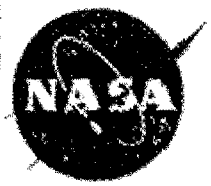
VERSION 3

# INSTRUCTIONS AND TEMPLATE FOR CREATING A LEAD-FREE CONTROL PLAN

## TABLE OF CONTENTS





# *LFCP Template Instructions*

Template has same section numbers and headings as GEIA-STD-0005-1.

Green Shading : *short reminder of requirement statement from GEIA-STD-0005-1, removed by author*

Blue font :*fill in information on materials, reliability, configuration management, procedures, etc.*

The instructions assume that the Plan author has access to the information, either through personal knowledge, or through other knowledgeable personnel. ← can "standard" methods be provided ?

[Supplier name] :*fill in the name of the organization responsible for implementing the Lead-free Control Plan*

[LFCP] :*fill in supplier's formal name or doc number*

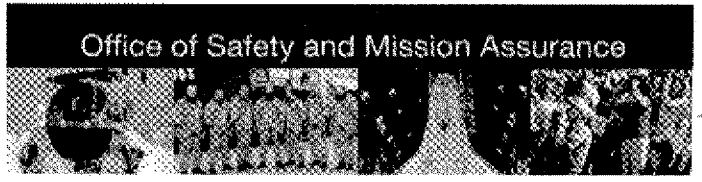
***[Bold Italicized ]*** :*fill in additional or custom information*

*Prior to review, remove the 1st section break and all text on pgs i through iv and remainder will be the LFCP.*

# *LFCP Template*

1. Cover Page
2. Table of Contents
3. Configuration Management table
4. Forward: 2 examples given, choose one or make your own
5. Purpose and Applicability: fill in LFCP name, fill in supplier name
6. Exclusions: describe exclusions from scope of the plan
7. References: GEIA provided
8. Terms, Definitions and Acronyms: 39 IPC and GEIA terms included
9. Objectives: author is instructed to address the following:
   - Reliability: how will this be demonstrated?
   - Configuration control and product identification
   - Caveats: remaining risks and limitations of use
   - Deleterious effects of tin whiskers: how mitigated?
   - Repair, rework, maintenance, and support

*How to prefer suppliers who are using this approach?*



# *Summary*

- PERM Consortium established standardized minimum baseline for Pb-free control in form of GEIA (TechAmerica) document set
- NASA policy requires Pb-free control per GEIA-STD-0005-1
- Where used, how used, logistics control, meets/exceeds reliability needs is emphasis
- NASA will provide a template for facilitating the use of GEIA-STD-0005-1
- Author should be process owner. One-size-fits-all may not work for establishing the reliability piece