PURPOSE

This Technical Guidance document provides information pertinent to the rework, repair and modification of military electronics system to address impacts of Lead-free (Pb-free) solders and termination finishes.

SCOPE

This document applies to all DoD owned or managed electronic equipment and addresses the concerns of using Pb-free alloys, termination finishes and materials encompassing systems, subsystems, assemblies, piece parts, and associated support equipment. It also pertains to depot, intermediate, and organizational levels of maintenance, as well as upgrades, and temporary or permanent modifications. This document is authorized for use by all U. S. Government agencies.

REFERENCED DOCUMENTS

AA-08-02 dated March 2008
SOLD-08-02 Technical Guidance for Lead-Free Electronics
GEIA documents
J-STD-609 Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Pb-Free and Other Attributes
MIL-STD-1276 DoD Interface Standard - Leads for Electronic Component Parts
MIL-PRF-19500 Performance Specifications - Semiconductor Devices, General Specification for
MIL-PRF-38534 Performance Specifications - Hybrid Microcircuits, General Specification for
MIL-PRF-38535 Performance Specifications - Integrated Circuits (Microcircuits), General Specification for

BACKGROUND

July 1 2006, when the European Union's Restriction of Hazardous Substances (RoHS) Directive went into effect, marked the start of the first government sanctioned ban on new electronics products manufactured with solder containing Lead (Pb). For over fifty years, the electronics industry has relied on Tin-Lead (SnPb) solder as the primary means of interconnection between electronic devices. The reliability of SnPb interconnections is well known, well studied, and well documented. RoHS and other international and domestic mandates to eliminate materials deemed hazardous has forced the electronics industry to adopt solders free of Pb. While military electronics are considered "out of scope" for these Pb-free imperatives, the reality is that the consumer market drives the electronics industry, not the military. To remain competitive electronics companies and their suppliers worldwide must change to solders and materials compatible with Pb-free assembly. Electronics for high reliability applications, such as the military, rely heavily on commercial piece parts, and, in some cases, circuit boards, assemblies, and equipment, the majority of which have been or will transition to Pb-free. Based on the scientific information available today, there are increased reliability risks by using Pb-free in military electronics. These risks include the spontaneous formation of Tin Whiskers from pure Tin (Sn) finishes, reduced Pb-free solder joint integrity, and the potential damage from higher Pb-free processing temperatures. Until the impact of Pb-free on the reliability of military electronics is understood, Pb-free use should be controlled and its risks managed. Because there is no drop-in replacement for SnPb solder, the conversion of the commercial supply chain to Pb-free piece parts, circuit boards, and assemblies requires due diligence to ensure that the reliability of military electronics is maintained and not adversely impacted from the unwitting introduction of Pb-free.

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DISCUSSION

Pb-free solders and finishes may decrease the reliability of systems or subsystems, and system performance and safety impacts may result from the following:

- Pb-free termination finishes may be common in commercial-off-the-shelf piece parts.
- Pb-free solder alloys may be common in commercial-off-the-shelf assemblies.
- SnPb solders and finishes on assembly piece parts may be difficult to procure.
- SnPb solders and finishes may not be available regardless of contract or specification.
- SnPb versus Pb-free piece parts may be difficult to identify in pre-assembled subsystems.
- SnPb versus Pb-free soldered assemblies may be difficult to identify through visual inspection.
- System production and maintenance personnel may inadvertently mix SnPb and Pb-free solders.

GUIDANCE/RECOMMENDATIONS

The following recommendations are intended to help program managers plan for and meet the challenges imposed by the commercial transition to Pb-free solders and finishes. Addressing these key areas of concern should provide assistance to all personnel to mange the situation.

- Avoid the use Pb-free solders, termination finishes, and materials in critical military electronics.
- Use eutectic SnPb solder for all rework and repair actions where the solder alloy can not be verified as Pb-free through approved documentation and/or analysis.
- Use Pb-free solder alloys only in rework actions where positive identification of the Pb-free alloy can be confirmed through approved documentation and/or analysis.
- Establish a Lead-Free Control Plan (refer to SOLD-08-06) to ensure that any procured items (components, bare boards, etc) are of the specified metallurgy.
- Implement procedures to mitigate the growth of Tin Whiskers.
- Store all electronic parts in their individual unit packaging to preserve traceability of contract numbers, CAGE codes, J-STD-609 markings, etc..
- Segregate SnPb and Pb-free parts, solders and materials.
- Use the GEIA Pb-free documents as the means for Pb-free control and risk management should implementation become unavoidable.

REPAIR AND REWORK ACTIONS/SOURCES OF REPAIR ACTIONS:

The reliability of electronics assemblies and systems manufactured with eutectic SnPb processes and components is well known. Although not quantified, the detrimental impact of using high Sn content or pure Sn [increased amounts of Sn with the absence of at least 3% Pb by weight] are also well documented. In addition, there is little to no data, guidance, and reliability prediction models available for electronics components, assemblies and systems manufactured with a Pb-free process.

Utilization of Pb-free electronics components and solders in legacy military systems will impact the following in currently undetermined ways.

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- System Configuration and Management thereof; to include engineering and procurement data.
- Assembly Repair and Rework Processes; resulting in unknown reliability and maintainability issues and requiring increased capital expenditures to effect repairs.
- System Operational Safety, Suitability & Effectiveness; Unknown reliability impact to system operation and function.

Because of the unknown impact to system reliability and maintainability the use of "Lead-free" parts and solders should be limited to systems where Pb-free processes have been qualified and approved. The repair of assemblies installed into DoD equipment must be completed using approved processes and materials. A deviation to use Pb-free components or solders should be approved by the responsible engineering authority and changes reflected in configuration management documents. To prevent the use of unspecified or non-qualified Pb-free components and solders, the assistance and cooperation of the various DoD supply chain managers, depots and sources of repair. Therefore, it is imperative that that all DoD sources of repair take the following actions:

- Ensure that all personnel are trained in the awareness of Pb-free issues and its impacts.
- Ensure that all maintenance technicians follow approved rework and repair practices, including:
  - Clean and re-tin leads (terminations) of each component before repair.
  - Use of approved soldering equipment and equipment maintenance procedures.
  - Reapplication of conformal coating, if removed for repair.
- Ensure that electronic components are installed using approved SnPb eutectic solder, except where non-eutectic or specialty solders are specified in the design data or in future systems yet to be assigned.
- Ensure locally purchased and received components meet the applicable specification for the part ordered. Additional approved component lead (termination) materials and finishes may be found in MIL-STD-1276. Additional requirements for including Pb when utilizing Sn may be specified; refer to MIL-PRF-19500, MIL-PRF-38534 & MIL-PRF-38535, and other Military Performance and Specification documents.

Additionally, due to the unknown nature of parts provided by DLA, and their "Bench Stock" managers under existing DLA Integrated Prime Vendor contracts, as well as those parts locally procured by the source of repair, incoming inspection should be performed by the source of repair on every part received to be installed into DoD equipment.

- Inspection and screening may be by any applicable means to include but not limited to: reviewing purchasing records to verify that the parts in question were received by your organization prior to 1 January 2003. Inspection and screening may be accomplished by visual inspection to verify the smallest unit package (shipping package and/or part package) is not marked “e3” or Non-Destructive Inspection (NDI) to verify lead (termination) finish materials do not contain less than 3% Pb by weight when in the presence of Sn.
- All parts bins, staging areas and piece parts packaging should be clearly marked and segregated to prevent unintentional mixing of materials and accidental installation into assets for which the use of unauthorized Pb-free parts are prohibited.

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- Existing stock should be screened and parts containing less than 3% Pb by weight that do not meet system and configuration requirements must be purged from local supply via applicable deficiency reporting system.

Should it become necessary to use a component with lead (termination) finish material containing less than 3% Pb by weight, the source of repair will contact the cognizant System Engineering office prior to installation to determine the proper course of action whenever a Pb-free part is identified.

- If approved by the responsible System Engineering office, any repairs utilizing Pb-free components must be recorded in the applicable maintenance data collection system.
- At a minimum, the part number and serial number of the assembly and the part number and reference designator of the part installed must be recorded. A description providing the type of Pb-free component installed and the name of the approving engineer must be recorded for tracking purposes and possible future analysis.

CONCLUSION

Pb-free electronics will affect the Military as long as the conversion of the commercial supply chain to Pb-free components, boards, and assemblies and COTS integration persist. Managers of defense (as well as other high performance) programs must be aware of the risks associated with use of Pb-free technology to control/manage the situation. Identifying the risks, and subsequent mitigation plans, is facilitated by the use of the GEIA documents as well as a Lead-Free Control Plan. Acceptance of this situation and a subsequent proactive approach to control and risk management will lead to the continued reliable operation of military electronics.

POINTS OF CONTACT

Contact the DoD Soldering Technologies Working Group at DoD_Lead-free@navy.mil for additional information.

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