Reference:

G. Corocher and T. Becker, *Lead free transition for the European space electronic industry*, 4th ESA REACH Workshop, ESA HQ Daumesnil, Paris, 18th October 2022

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Lead Free Transition Working Group

G. Corocher (ESA TEC-MSP)

4th REACH Workshop

PARIS

18/10/22

OUTLINE

Overview of the Lead Free Transition Working Group

Why the European Space Electronic Manufacturing need to transition to Pb free?

What are the technical issues to solve?

How is the Road Map approaching the transition?

The challenge(s) ahead

LFTWG

In 2018 metallic Pb was added in the REACH candidate list of SVHC.

This triggered the decision of the MPTB and CTB to launch a joint task force to assess the situation and to define a Road Map for the transition of the European Space Electronic sector to Pb free.

The Task force issued a Road MAP in April 2020 and the formation of a dedicated working group for the Pb free transition was agreed by MPTB and CTB:

- The WG is temporary and will last the time of the Lead-free transition for the European Space Sector
- It does coordinate the Roadmap development and implementation with relevant stakeholders. This includes other concerned CTB and MPTB WGs to avoid conflicts and duplications.
- It does monitor legislative evolution and report on the Roadmap implementation
- It promotes the Roadmap actions with relevant funding bodies

LFTWG Status September 2022

LFTWG members:

Alter

Airbus

Arianegroup

Beyond Gravity

CNES

DLR

EDA

ESA

ICME

Reach Law

Tesat

Thales Alenia Space

Sodern

SPUR

UK Space

LFTWG Observers:

IRT

RISE

HTV gmbH

Why the European Space Electronic Manufacturing needs to transition to Pb free

The road map for the transition of the European Space Electronics Manufacturing to Pb Free was issued in April 2020 by the Pb Free Task Force.

In the road map it is assessed that:

- In the short term (< 5 years): no risk associated with regulation or obsolescence of SnPb Solder
- In the medium term (< 10 years): very low risk from Regulation and very low risk associated with SnPb solder obsolescence
- In the long term (> 10 years): low risk from the Regulatory side and potential risk associated with SnPb materials obsolescence.

Why the European Space Electronic Manufacturing needs to transition to Pb free

T. Becker/REACH Law – regulatory background

REACHLAW
COMPLIANCE. SUSTAINABILITY.

4th ESA REACH Workshop
18 October 2022
ESA HQ Daumesnil, Paris

Lead metal: Regulatory background

Workshop Session III – Managing substitution and obsolescence

Tim Becker, Senior Legal Advisor

Lead metal: Regulatory background

Regulatory landscape for Lead metal

- **CLP**: Harmonised classification as Toxic for Reproduction, Category 1A
- **30+ pieces of EU legislation** already govern Lead and its compounds
- **RoHS** (Directive 2011/65/EU): Lead is restricted in EEE, but with some exclusions, incl. for *"equipment designed to be sent into space"*
- 2018: Inclusion in the **REACH Candidate List** of SVHCs for Authorisation
- 2020: Dedicated action in the Commission **CSS** to strengthen the protection of workers by **lowering existing occupational limit values for lead**

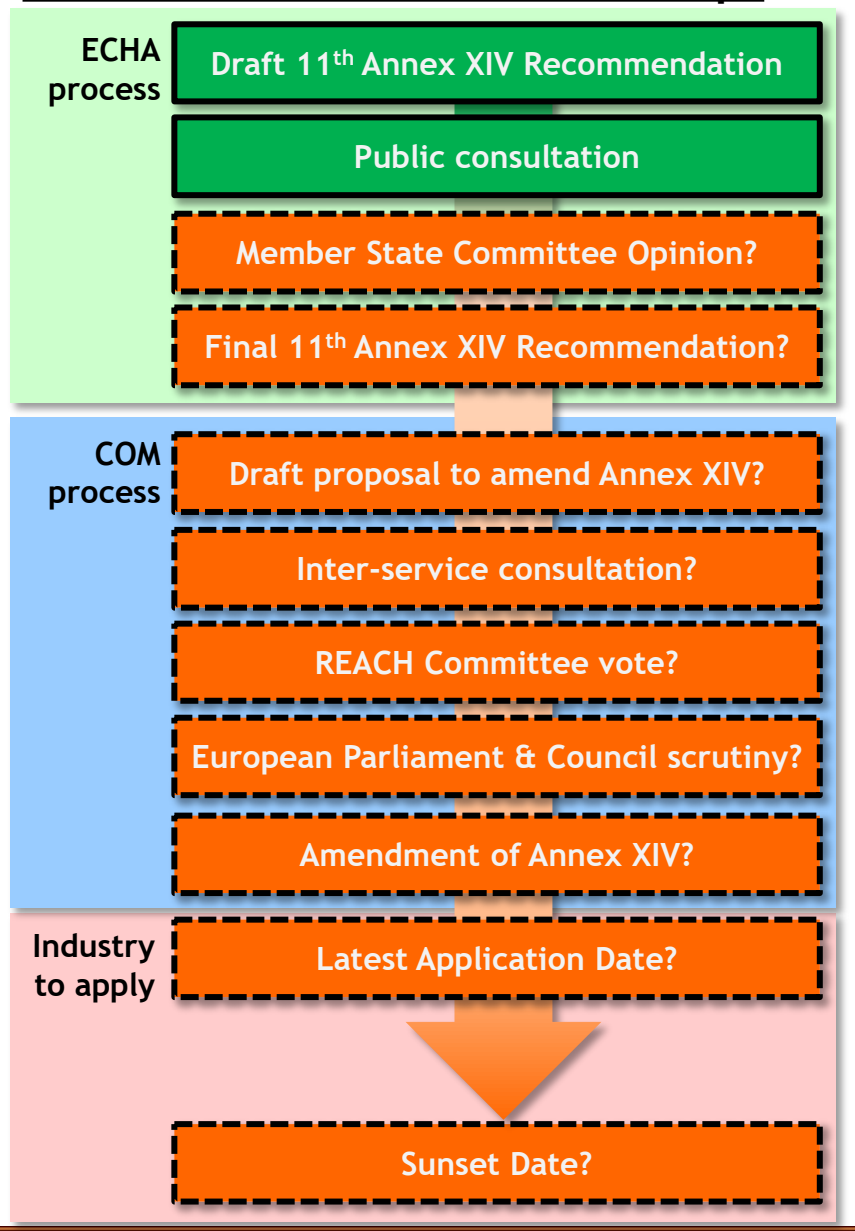
- 2 February 2022: Lead in **ECHA's *draft* 11th Recommendation of Priority Candidate List Substances to be included in REACH Annex XIV** (Authorisation List)

Lead metal: Regulatory background
Outlook of future regulation of Lead

- Current baseline: OEL revision (*awaiting COM proposal*) and specific REACH Restrictions

- Likelihood of REACH Annex XIV inclusion?
  - Numerous steps ahead – No automatism!
  - Further uncertainties mainly due to REACH Revision (incl. Authorisation & Restriction Reform)

- *In case* of Annex XIV inclusion: Good case for authorisation of space applications without alternatives could be made, but **disproportionate impact and efforts expected** (up to 200+ AfAs for soldering only)



Summary

No REACH authorisation requirement for Lead today nor decided!

But substitution pressure is increasing

→ work of the Lead-free Transition Working Group is critical

Why the European Space Electronic Manufacturing needs to transition to Pb free

The road map discussed also factors defining the market pressure pushing the Space sector toward the transition to Pb Free technologies:

- Components development is driven by sectors already transitioned to Pb-Free: State of the Art components are becoming less available for SnPb based assembly processes.
- New Space : Shorter mission, Mega constellation, different approach to system level reliability.
- Traditional Space Electronics manufacturers facing competitions from companies entering the New-Space market
- Cost reduction via increased use of COTS

Why the European Space Electronic Manufacturing needs to transition to Pb free

The road map assessed that:

“ From the regulatory point of view there is no immediate requirement to transition to Pb free. However the pressure to introduce COTS in the space projects is already forcing the transition and this is anticipated to accelerate significantly in the near/medium term. European space manufacturers and Space Agencies need to prepare for this in order to maintain their competiveness in the future.”

Two years down the road it can be said that this assessment is still correct. The pressure to use COTS and to reduce costs is constantly growing increasing the push on the European Space Industry toward the Pb free transition.

What are the technical issues to solve?

- Pure Sn finishing and Sn Whiskers mitigations
- Selection and characterization of most suitable Pb free solder alloys for Typical Space Applications.
- Identification of possible Pb free alloy systems suitable for extreme environments (currently no suitable Pb free alloys are available for very low temperature or high temperatures application)
- Impact of use of Pb free alloys on PCB manufacturing (increased soldering temperature inducing higher stresses on PCB)

What are the technical issues to solve?

- Impact of use of Pb free alloys on component manufacturing
- Impact of Pb free alloys on Assembly processes (use of different materials, impact on soldering systems)
- Reliability of the assembly (different metallurgy from SnPb alloys, different failure modes, different aging mechanism to SnPb)
- Standardization (workmanship standards, approach to verification of assembly processes to be redefined, modeling)

LFTWG Road map

The road map identifies 4 main topics:

- ***Roadmap for using COTS with the standard SnPb Assembly Process on standard leaded PCBs***. **This is very urgent since it is necessary for the widespread introduction of COTS in Space Programmes**

- ***Roadmap for using lead-free PCBs with the standard SnPb Assembly Process***.

- ***Roadmap for assessment of Sn whiskers mitigation approach.*** **Necessary for the widespread introduction of COTS in Space Programmes**

- ***Roadmap for the introduction of lead-free solder alloys***.

Road Maps relationship:

Estimated cost ~11 MEuro

LFTWG Road map

Road Maps targets:

ECSS standards for Pb free assembly

Workmanship standards

Fatigue models for assembly

Impact of Pb free assembly processes on PCB

Assembly reliability characterization

Assessment of component finishes for use with SnPb processes

Assessment of Sn Whiskers mitigation methods

Assessment of Pb free finishes of PCBs

Pb free alloys selection

Pb free alloys characterization

Impact of Pb free assembly on EEE parts (ESCC)

The challenge(s) ahead

The technical challenges to solve have been presented and discussed in details in the road map.

The challenge for the LFTWG is to successfully coordinate the effort to solve these challenges and set up the conditions for a **reliable use of Pb free technologies in the future Space missions**.

The challenge(s) ahead

The experience reported by consortia (ELFNET, Manhattan Project) which have worked on Pb free in the past (2000) shows that:

- Road maps have been proposed in the past but most often not fully implemented
- Results of activities are not always publicly available
- Excessive fragmentation in R&D activities=> difficulty to correlate results
- Different pace between Academic and Research institution with respect of Industry needs leading Industry to run in house activities and not willing to share data.
- Difficulty in getting founding for R&D as the Pb free topic is perceived as non innovative.
- Difficulty in getting founding: being a common issue to different fields and organizations there is resistance to act on it (why should my organization/project/company pay for this…?)

The challenge(s) ahead

The LFTWG is aiming to:

- Facilitate the communication among companies working on Pb Free R&D activities
- Promote exchanges and discussion within the European industry addressing the basic, fundamental questions which are preventing the use of Pb free on the high reliability applications.
- Promote and facilitate an exchange of data and information still respecting property information of the different actors.
- Define test approaches that can aid the comparison of data from different research activities
- Coordinate the proposal of new activities to funding bodies in coherence with the progress of the road map
- Promote the implementation of the road map with funding body

Conclusions

The transition of the Space Electronic Manufacturing to Pb free technology

- Is pushed by a combination of market and regulatory pressure
- Market factors are dominant in forcing the transition in shorter period
- Several technical issues need to be solved to use Pb Free technologies in High Reliability Space Applications
- The alternative alloys used are fundamentally different from the SnPb alloys used so far. A full understanding of these materials and their failure mode is needed.

Conclusions

- The transition impacts a very large supply chain (OEM, PCB and component manufacturers)
- It requires a coordinated effort from all affected entities
- It is strategic goal for future competitiveness of the European Space Sector
- It is an opportunity for the European Space Electronic Manufacturing Sector

Any Questions?

Back up slide

What is happening elsewhere

US Congress Approves Funds for R&D on Pb-Free Electronics in High-Rel Applications (/ca/editorial/menu-news/34765-us-congress-approves-funds-for-r-d-on-pb-free-electronics-in-high-rel-applications.html)

Published: 22 December 2020
by Mike Buetow

BANNOCKBURN, IL – The US Congress on Monday approved $10 million for research into the issues surrounding lead-free electronics in mission-critical applications.

The funds are part of the fiscal 2021 defense appropriations bill, which President Trump is expected to sign.

A number of trade groups including IPC had called for these funds to be included under the assertion that the high-rel sector has been slow to adopt lead-free materials, putting it at risk of falling behind best practices.

IPC said industry experts believe a five-year, $40 million investment in a public-private R&D program would yield more than $100 million in US defense savings per year and improve military readiness and overall innovation. The Congress provided $5 million for such R&D in FY 2020.

Over the past 15 years, the commercial electronics industry has largely phased out its use of lead in electronic components and circuit board assemblies, driven by government regulations and concerns about lead's harmful effects on human health and the environment. However, the aerospace, defense and high-performance (ADHP) sectors have been reluctant to migrate to lead-free electronics because there is inadequate data on the reliability of lead-free components in ADHP applications.

The gap between commercial and defense electronics is growing wider as lead-free becomes more established in commercial technologies, and as governments – particularly in Europe – have implemented more stringent rules on the use of lead. Today's defense electronics are now 15 to 20 years behind the commercial market in terms of the underlying materials used, undermining supply chain resiliency and technological superiority.

"This vote is a win for US taxpayers, defense readiness, and the electronics industry supply chain," said Chris Mitchell, IPC vice president of global government relations.

"The migration of the commercial industry to lead-free electronics has created supply-chain concerns for the ADHP sectors that can only be overcome through public-private R&D," he added. "These funds will support a collaborative research effort that will help ensure that mission-critical systems have full access to cutting-edge electronics from a robust global supply chain."

"Together with our partners in the Pb-Free Electronics Risk Management (PERM) Council, IPC will continue to advocate for a proactive, long-term approach to this issue," Mitchell added.

https://www.purdue.edu/newsroom/releases/2021/Q1/purdue-to-co-lead-u.s.-department-of-defense-funded-project-to-advance-adoption-of-lead-free-electronics.html

The US Congress approved $10 million for research into the issues surrounding lead-free electronics in mission critical applications as part of the 2021 fiscal appropriations bill

The European Space Industry needs to take actions in order to maintain its competitiveness in electronic manufacturing in the medium term.