



NEMI Pb-free Task Group Report

***Edwin Bradley, Carol Handwerker, John Sohn, Jasbir Bath,
Rich Parker, Rick Charbonneau, Ron Gedney***



2002 APEX Free Forum

January 23, 2002



Presentation Agenda

1:30-1:45p	General project overview	Edwin Bradley (Motorola)
1:45-2:20p	Pb-free Alloy Database	Carol Handwerker (NIST)
2:20-3:00p	Solder Joint Reliability	John Sohn (NEMI/Lucent ret.)
3:00-3:15p	BREAK	
3:15-3:50p	Soldering Process	Jasbir Bath (Solectron)
3:50-4:30p	Component overview	Rich Parker (Delphi)
4:30-4:45p	Final Q&A for panel	All

- Short Q&A after each presentation.
- Today's slides will be posted at <http://www.nemi.org> by Feb. 4.



Project Participants

OEMs/EMS

Agilent
Alcatel Canada
Celestica
Compaq
Delphi/Delco
IBM
Intel
Kodak
Lucent
Motorola
SCI
Solectron
StorageTek

Solder Suppliers

AlphaMetals
Heraeus
Indium
Johnson Mfg.
Kester

Components

ChipPac
Intel
Motorola
Texas Instruments
FCI USA Electronics

Govt. & Other

NIST
SUNY-B/IEEC
ITRI (US)
IPC
BTU
Universal
Vitronics-Soltec



North America Electronics Goal

- **N. American OEM's/EMS' need to prepare processes to be able to deliver Pb-free products in 2001 with an 'eye' to total Pb-elimination by 2004.**
 - **Japan driving "Green" consumer products.**
 - **Timetables seem to be holding (2001-2003)**
 - **NEMI companies received serious inquiries.**
 - **EU legislation banning lead in electronics in 2004, proposal pushed out to 2007.**
 - **Individual Countries can shorten timeframe.**

NEMI engaged the technical side of Pb-free related to compatibility with existing assembly infrastructure.



Legislation

- **Europe: WEEE/ROHS. WEEE expected to come to a vote in Summer 2002. Sticking point is the product take-back and company responsibility of ROHS.**
- **US: new rules regarding reporting of Pb, but no legislation on horizon for banning Pb or Pb-containing solder.**
- **Asia: No legislation, but Japanese companies are still actively engaged in eliminating Pb from electronics.**

Push back of WEEE date + lack of other legislation has taken immediate pressure off drive to implement.



Major Task Group Objectives

- **Demonstrate capability to deliver products in volume in 2001 with Pb-free interconnects.**
- ✓ **Facilitate a common Pb-free solder alloy composition for N.American electronics assembly.**
- ✓ **Work with component and PCB suppliers to develop specifications necessary to meet higher temperature reflow conditions.**
- ✓ **Develop criteria that industry can use to evaluate Pb-free processes.**
- ✓ **Monitor environmental legislation to adjust activities if necessary.**
- ✓ **Share our information in a timely manner to promote common path to Pb-free .**

Commonality is an overarching goal for all NEMI activities



Worldwide Pb-free Activities

- **NCMS** –recent high temperature solder alloy project report released, Pb-free solders performed well.
- **Gintic (Singapore)** – Consortium working on process and reliability of Pb-free solders.
- **JEITA** – Continuing work on solders and tin whiskering.
- **Soldertec** – Performed reliability tests, supported SnAgCu. Now working on Tin whiskering.
- **JEDEC** – 020 revision with elevated temperatures for MSL testing out for ballot.
- **IPC** – Support with meetings, standards development.
- **EPA** – Life Cycle project. Proposal for companies to partner on a project and split cost with EPA.
- **GECI** – Promoting global cooperation and commonality.



Cooperation/Commonality

- **Maximum benefit achieved through world wide agreement and cooperation.**
 - **NEMI is member of GECI (Global Environmental Cooperation Initiative). HDPUG, SEM, Soldertec, MEPTEC, SAC, ITRI Taiwan also members.**
 - + **Promoted single alloy SnAgCu**
 - + **Definition of Pb-free (0.2%)**
- **Update/create JEDEC standards.**
 - **Working with committee on J-STD-020.**



Major Project Activities

- **Alloy – Carol Handwerker, NIST**
 - Alloy Material Property development
 - Interface w/academia, gov't agencies
- **Components/PCBs – Rich Parker, Delphi**
 - Effect of High temperature reflow
 - Pb-free terminations
- **Solder Reliability – John Sohn, NEMI**
 - Transparent test procedure
 - Common data to share with industry
- **Process Development – Jasbir Bath, Solectron**
 - Generic process for Reliability test boards
 - Process characterization benchmark
- **Tin Whisker – Swami Prasad, ChipPAC**



Solder Alloy Team

Mission: To provide the Task Force with critical data and analyses needed for making decisions with respect to solder alloys, manufacturing, and assembly reliability.

- ✓ **NEMI chose Sn-Ag-Cu, rest of world moving that direction.**
- ✓ **Developed “best practices” experimental procedures to measure the mechanical, thermal, electrical and wetting properties of lead-free solders.**
- **Developing Solder Reliability Modeling Guidelines**
 - ✓ **Critical review of reported deformation data and models**



Component Team

Mission: To collectively work on identifying and recommending the best materials for the supplier industry to use, in delivering compatible components and PWBs that will meet the Pb-free requirements sent forth in the main task group.

- ✓ **Previously characterized component survivability at elevated reflow temp.**
- ✓ **Characterized the optimum operating profile of maximum time, temperature and environment exposures.**
- ✓ **Recommendation for component temperatures**
 - ✓ **Reflow characterization, peak temp/board delta-T**
 - ✓ **JEDEC using our data for proposal for new standard, consistent with our position.**
- **Working with IPC (ex. ITRI) PCB project for evaluation of PCB laminates.**



Assembly Process Team

Mission: To demonstrate capable processes for lead-free soldering of printed wiring board assemblies.

- ✓ **Most thorough study of lead-free assembly to date**
- ✓ **Demonstrated high quality joints for reliability testing**
- ✓ **Report generation and review**
 - ✓ X-ray solder inspection of BGAs
 - ✓ Acoustic microscopy of packages
 - ✓ AOI of solder joints
 - ✓ Solder paste performance
 - ✓ Rework



Reliability Team

Mission: To perform reliability testing for selected solders, components and board finishes using an approved test vehicle.

- ✓ **Thorough experiment covering various components, solder/lead combinations, failure analysis, statistical analysis.**
- ✓ **Reliability tests**
 - **Thermal Cycling (nearly complete)**
 - ✓ **Three-point Bend Testing**
 - ✓ **Electrochemical Migration**
- **Failure analysis and root cause of TC failures**
 - ✓ **Red dye penetrant**
 - ✓ **Metallurgical cross-section**
 - ✓ **Very detailed and thorough FA process.**
- ✓ **Statistical Data Analysis on TC results**
- **Data to go into alloy group database**



Project Schedule

- **Project Final Report – May 2002**
- **IEEE /Wiley Book: 1Q 2003**
 - **Integrated book covering major points of this project along with other published work to date.**