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Electronics Manufacturing Solutions

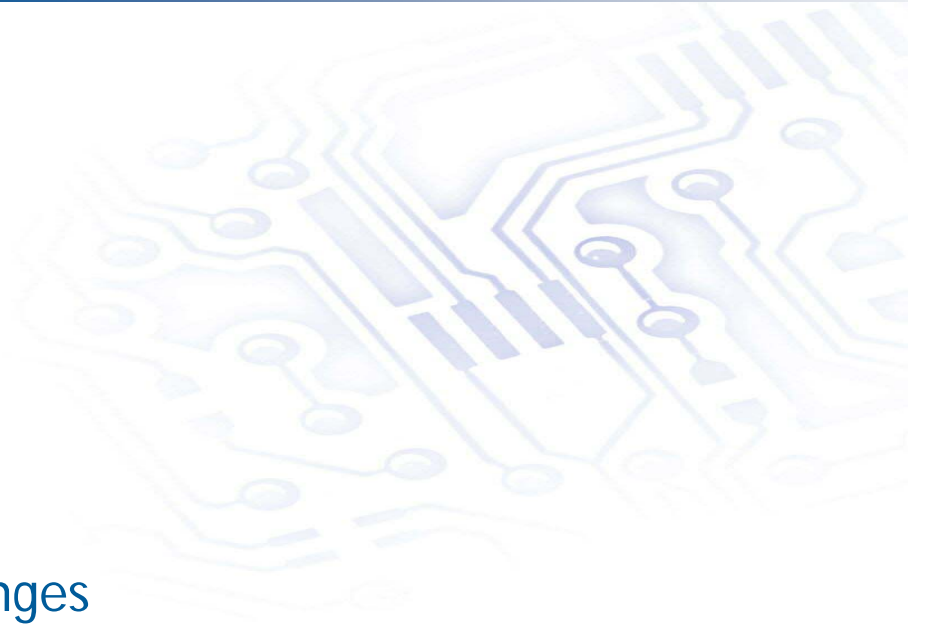
RoHS & WEEE Compliance

May 2007



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- 🌱 Overview of RoHS Legislation
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Key Dates

✿ 13 August 2005

- ✿ WEEE Directive mandates producers provide at least for financing of the collection, treatment, recovery and environmentally sound disposal of WEEE
- ✿ All products put on market after this date to be marked

✿ 1 Jul 2006

- ✿ Products put on the market to comply with RoHS directive



2002/96/EC - Waste Electrical and Electronic Equipment (WEEE)

✿ The directive addresses producer responsibility for the **Collection, Treatment, Recovery** and from the following Equipment classifications

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools
(with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices
(with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers



Producer Definition

- ✿ A **producer** is defined within the directive as anyone who:
- ✿ manufactures and sells electrical and electronic equipment under his own brand
 - ✿ resells under his own brand equipment produced by other suppliers, a reseller not being regarded as the “producer” if the brand of the producer appears on the equipment
 - ✿ imports or exports electrical and electronic equipment on a professional basis into a member state



"Grey Area" Products

- ✿ Products where electricity is not the main power source
 - ✿ Gas heating system with an electric thermostat
- ✿ Products where the electrical or electronic components are not needed to fulfil the primary function
 - ✿ E.G. Musical greeting cards
- ✿ Items which are electrical and electronic equipment that is part of another type of equipment or a fixed installation
 - ✿ E.g. A car radio
- ✿ The Technical Adaptation Committee are currently working to provide clarification on these products



Article 5 - Separate Collection

✿ “when supplying new product, distributors shall be responsible for ensuring that such waste can be returned to the distributor at least free of charge on a one-to-one basis as long as the equipment is of equivalent type and has fulfilled the same function as the supplied equipment.”



Article 6 - Treatment

- ✿ “Member states shall ensure that producers or third parties acting on their behalf, in accordance with Community legislation, set up systems to provide for the treatment of WEEE using best available treatment, recovery, and recycling techniques.”
- ✿ “...the treatment shall as a minimum include the removal of all fluids and a selective treatment in accordance with Annex II to the directive”



Article 7 - Recovery

- ✿ Recovery means any of the applicable operations provided for in Annex IIB to Directive 75/442/EEC
- ✿ Targets for the rate of recovery from equipment falling under categories 1,2 3,4,5,6,7,9 & 10 are identified in Article 7 (70-80%).
- ✿ “The European Parliament and the council, acting on a proposal from the Commission, shall establish new targets for recovery and reuse/recycling, including for the use of whole appliances as appropriate, and for products falling under category 8 (medical devices) of Annex IA, by 31 December 2008.”



Disposal

- ✿ Disposal is defined as “any of the applicable operations provided for in Annex IIA to directive 75/442/EEC”
- ✿ Annex includes requirement for disposal without endangering human health and without the use of processes or methods likely to harm the environment.
- ✿ Includes
 - ✿ Deposit into or onto land
 - ✿ Release into a water body
 - ✿ Incineration
- ✿ RoHS directive has been introduced to complement the environmentally sound disposal requirements of the WEEE directive



2002/95/EC - Restriction of Hazardous Substances (RoHS)

- ✿ “Member States Shall ensure that lead, mercury, cadmium, hexavalent chromium and PBB (polybrominated biphenyls) /PBDE (polybrominated diphenylethers) halogenated flame-retardants are phased out by July 1, 2006.”



2002/95/EC - Restriction of Hazardous Substances (RoHS)

✿ Substances Banned by RoHS Directive

Banned RoHS Substance	RoHS MCV Limits	Use in Electronics
Lead	1000 ppm	Solder & interconnects, Batteries, PZT devices, discrete components, CRT glass, PVC cables
Cadmium	100 ppm	Batteries, pigments (yellow), additives in plastics (PVC), detectors, LEDs
Hexavalent Chromium	1000 ppm	Metal finishes for chassis, fasteners, other alloys
Mercury	1000 ppm	Switches, paints, polyurethane materials, lamps, bulbs, displays
PBB/PBDE	1000 ppm	Used as flame retardants (plastics, housing, cables, connectors, fans, components)



Put On The Market - Definiton

- ✿ This term is defined in an FAQ document produced by the EU Environment Directorate General
- ✿ “The words ‘put on the market’ in Article 10 (3) of the WEEE Directive and Article 4 (1) of the RoHS Directive refer to the initial action of making a product available for the first time on the Community market. This takes place when the product is transferred (e.g. physical hand-over or transfer of ownership) from the producer to a distributor or final consumer or user on the Community market.”
- ✿ “Making a product available for the first time refers to each individual piece of equipment put on the market after the date for the substances restrictions (that is July 2006), and not to the launch of a new product or product line. Moreover the concept of putting on the market refers to each individual product, not to a type of product, irrespective of whether it was manufactured as an individual unit or a series.”



Scope

✿ “Without prejudice to Article 6, this Directive shall apply to electrical and electronic equipment falling under 1,2,3,4,5,6,7 and 10 set out in Annex IA to Directive No 2002/96/EC (WEEE) and to electric light bulbs, and luminaires in households”

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
10. Automatic dispensers



Scope

- ✿ RoHS does not apply to WEEE equipment categories 8 & 9, medical devices, and monitoring and control instruments
- ✿ “This directive does not apply to spare parts for the repair, or to the reuse, of electrical and electronic equipment put on the market before 1st July 2006”
- ✿ Specific applications exempt from legislation listed in Annex to the directive
- ✿ Further requests for exemption currently under consideration by the RoHS Technical Adaptation Committee



Applicability to Medical Devices

- ✿ “Before 13 February 2005 the commission shall review the measures provided for in this Directive to take into account, as necessary, new scientific evidence
- ✿ “In particular the Commission shall, by that date, present proposals for including in the scope of this Directive equipment which falls under categories 8 (medical devices) and 9 set out in Annex IA to Directive 2002/96/EC (WEEE)
- ✿ ITT to conduct the review issued in March, ETC - 10 to 12 months
- ✿ Eucomed in their response to the EC public consultation on RoHS both promote the continuing exemption of medical devices, and also identify a list of exemptions which would need to be added to the Annex to allow the exemption to be rescinded



Application for Exemptions

- ✿ Requests for exemptions should be made to the Commission and comprise an exemption checklist and supporting technical information
- ✿ All requests will be assessed by a commission appointed technical expert before being forwarded to the Technical Adaptation Committee (TAC)
- ✿ Following TAC review all requests will be subject to a stakeholder consultation exercise
- ✿ E-mail ENV-RoHS@cec.eu.int or post to European Commission, DG Environment, Unit A2 - Consultation Directive 2002/95/EC, B-1049 Brussels, Belgium



WEEE Compliance Strategy

- ✿ Register as a producer with a National body
- ✿ Establish method of compliance (company or compliance scheme)
- ✿ Collect data on sales, weights of products etc. & Budget for necessary fees/costs
- ✿ Mark equipment
- ✿ Develop information to assist third parties in treatment, recovery and recycling



Producer Registration

- ✿ All producers must register with a National Body within each member state in which products are sold
- ✿ Member states requirements broadly fall into three categories
 - ✿ Those member states whose governments or enforcement agencies would handle the registration
 - ✿ Those where public bodies would work in tandem with producer organisations
 - ✿ Those where producer lead bodies would register
- ✿ Specific member state requirements can be found in the Perchards report “Transposition of WEEE & RoHS Directives into national law of EU Member States and corresponding industry activities”



Compliance Schemes

- ❁ Compliance schemes will assume all treatment and recovery responsibilities under the WEEE Directive for it's members
- ❁ Waste Management companies Onyx, Valpak, and Wastepack have set up pre-compliance schemes
- ❁ Other schemes have been formed by producers Repic (primarily focusing on consumer waste) Gambica (focusing on category 3, 8 (medical devices) and 9 waste)



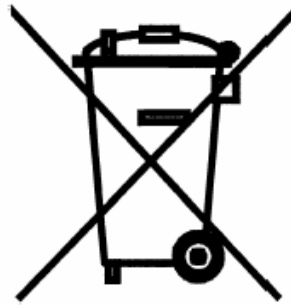
Budgeting

- ✿ Producers will be responsible for financing the collection, treatment, recovery and disposal of WEEE allocated to them
- ✿ WEEE will be assigned to producers on the basis of market share
- ✿ Annual sales data will therefore have to be provided to National Bodies to enable calculation of market share and appropriation of cost



Mark Equipment

- ✿ The WEEE regulations require producers to ensure that equipment put onto the market after 13 August 2005 is marked visibly, legibly and indelibly with the crossed out wheeled bin symbol.



- ✿ In addition, the Directive requires producers to ensure that products identify the producer, either brand name, trade mark, company registration number or other unique reference
- ✿ The RoHS Directive makes no reference to labelling requirements



Develop Information

- ✿ The WEEE regulations require producers to make arrangements to respond to requests for information to assist with the reuse, recycling and recovery of new equipment. This may include
 - ✿ Advice on the location of items and substances requiring treatment
 - ✿ Location and type of dangerous/hazardous substances, materials or components within the type of equipment.
- ✿ In the UK this information should be available within one year of placing the equipment on the market
- ✿ At present producers have the option of making such information available upon request, or take steps to make information available e.g through electronic media.



RoHS Transition Planning

- ✿ Component vendors who supply customers other than medical/ monitoring and control instrument customers will be driven towards RoHS compliance and lead-free manufacturing
- ✿ Over time, economies of scale will be realised from RoHS compliance, non-RoHS compliance will command a cost premium
- ✿ Many OEMs are transitioning current product sets to RoHS compliant
- ✿ OEMs not moving to RoHS compliance need to understand vendors product roadmaps to ensure continuity of supply



Typical Transition Plan

- ✿ Scrub BoMs
 - ✿ Part no. changes
- ✿ Obtain Declarations of Conformance from supply chain
 - ✿ Maintain records
- ✿ Perform RoHS compliance testing on critical/ high risk components a number of organisations are developing tests for this purpose
 - ✿ ERA Technology
 - ✿ Soldertec Global
- ✿ Product Qualification
 - ✿ Build lead-free samples
 - ✿ Performance testing
 - ✿ Reliability analysis
- ✿ Purge Inventory



Further Information

- ✿ European Commission Environmental Directorate General
http://www.europa.eu.int/comm/environment/waste/weee_index.htm
- ✿ UK Department of Trade and Industry
 - ✿ www.dti.gov.uk/sustainability/weee/index.htm
- ✿ Eucomed Environmental Task Group
 - ✿ www.eucomed.be/?x=4&y=3



Summary

- ✿ By 13 August 2005 producers will be financially responsible for the collection, treatment, recovery and environmentally sound disposal of their products at end of life
 - ✿ Need to define a compliance strategy now
 - ✿ Should address all all key elements reviewed today
- ✿ RoHS legislation will affect all OEMs whether or not products are exempt from the legislation
 - ✿ Need to evaluate how compliance will affect supply chain
 - ✿ Need to maintain awareness of changes in scope of the directive, specifically the exclusion of medical products



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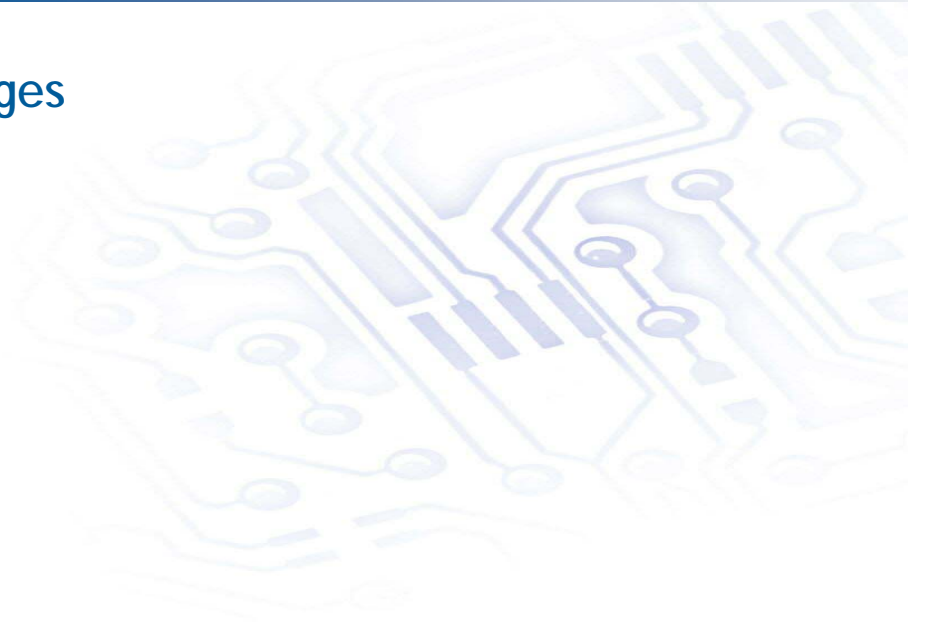
Lead-Free Process Overview

May 2005

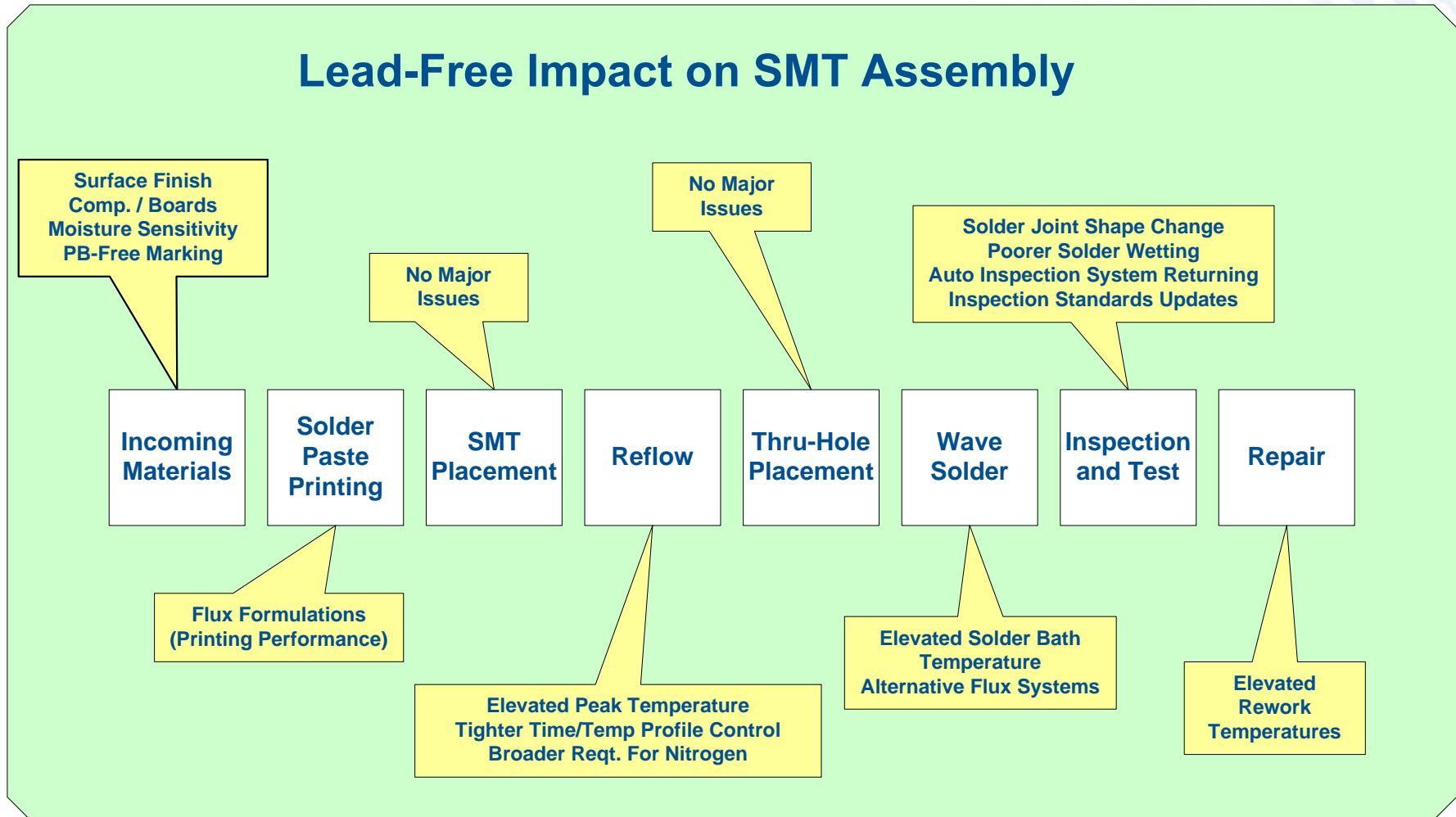


The Challenges of Lead-Free Processing

- ✿ Lead-Free Assembly Process Challenges
- ✿ Lead-Free Materials & Components
- ✿ CTS Lead-Free Qualification



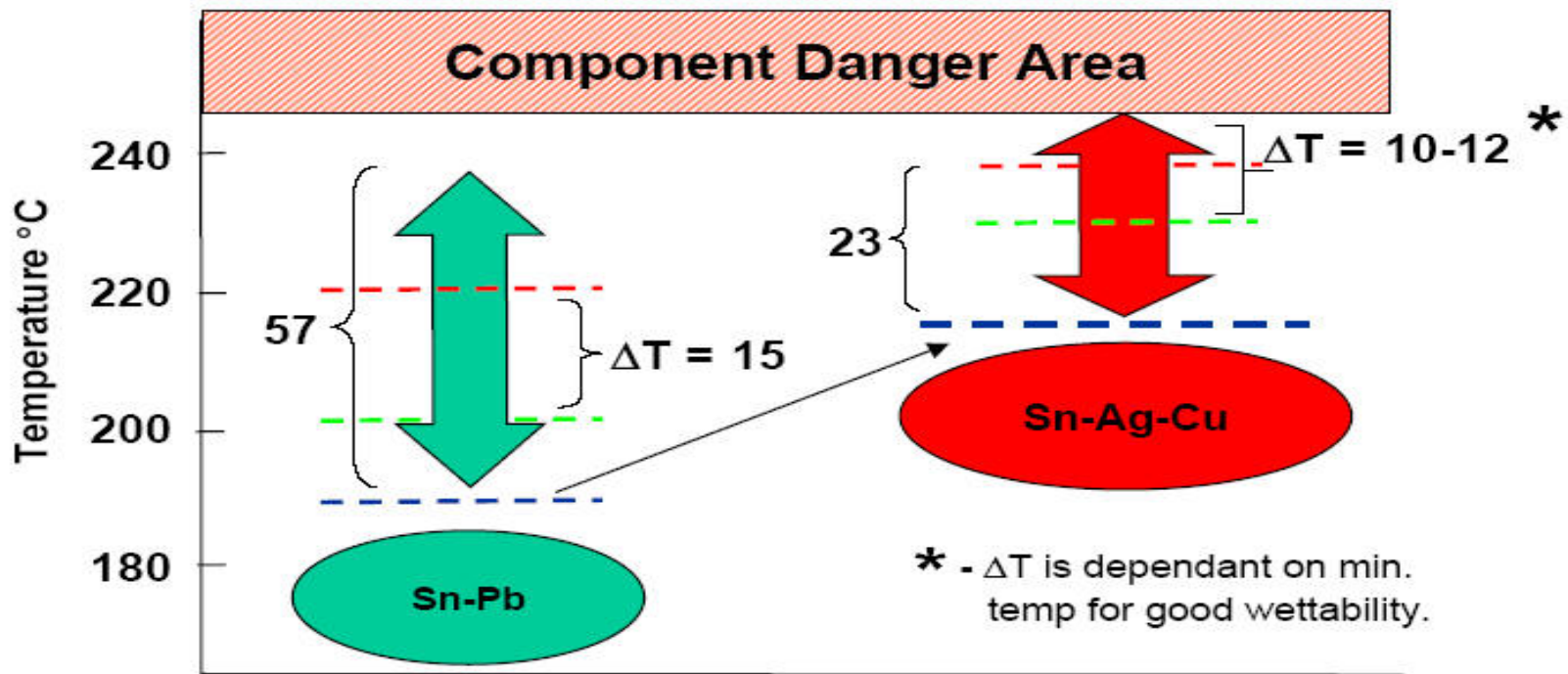
Lead-Free Assembly Process Impact



Lead-Free Assembly Process Challenges

Technical Challenges - Increased Temperatures

- Tighter Process Window

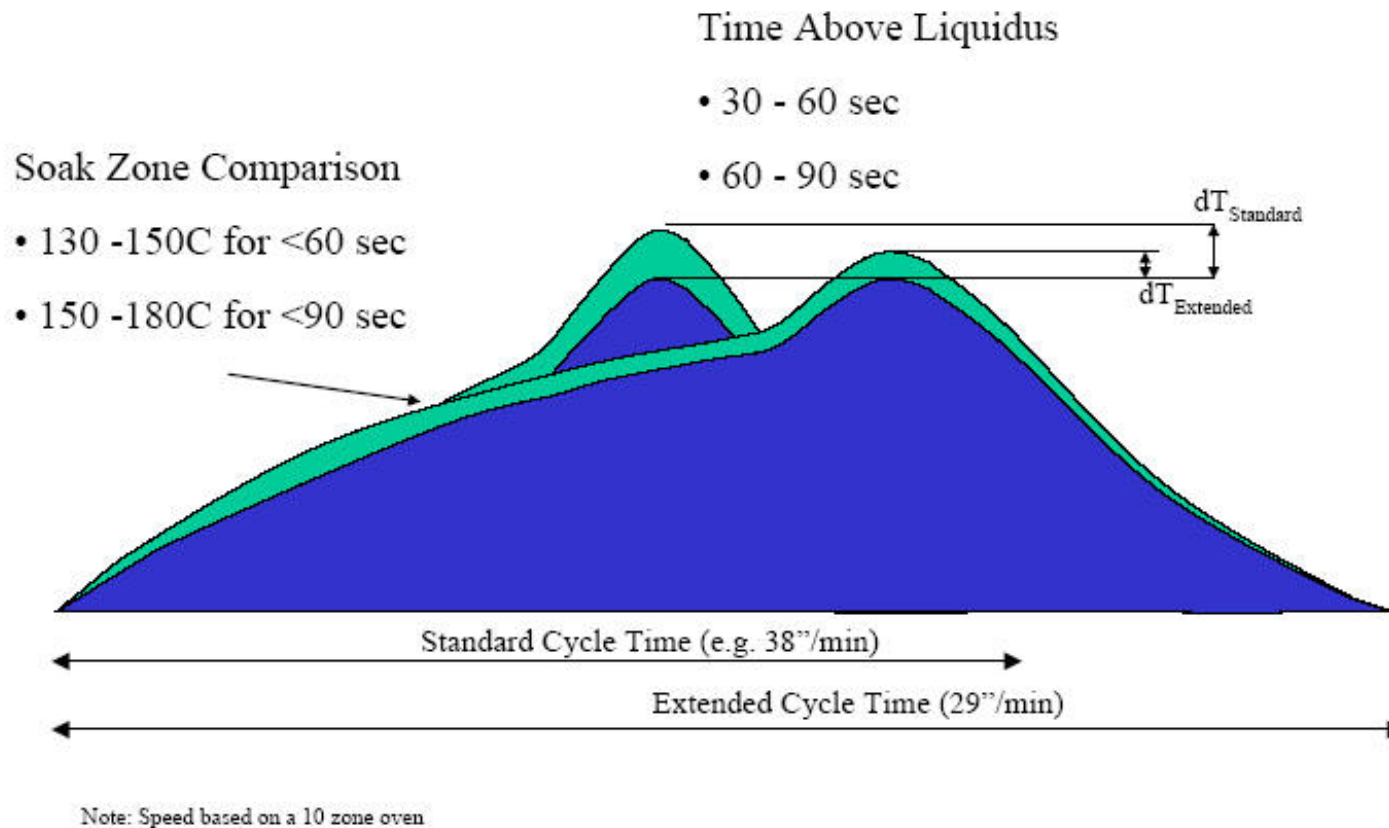


Legend:
- - Profile Max Temp
- - Solder Melting Point
- - Min. Temp for Good Wettability



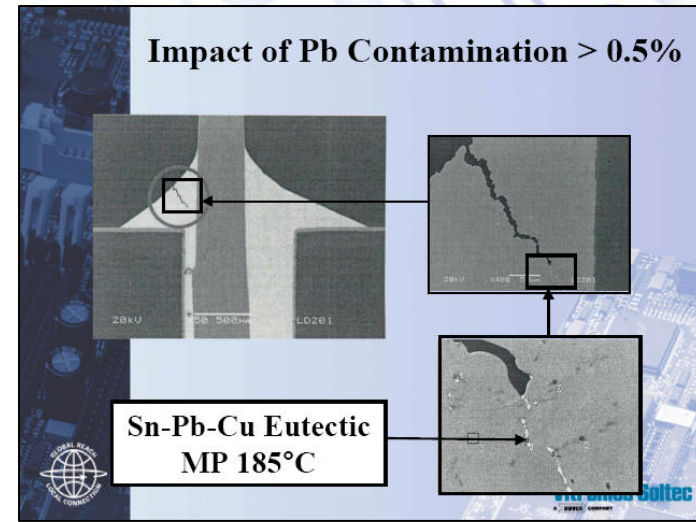
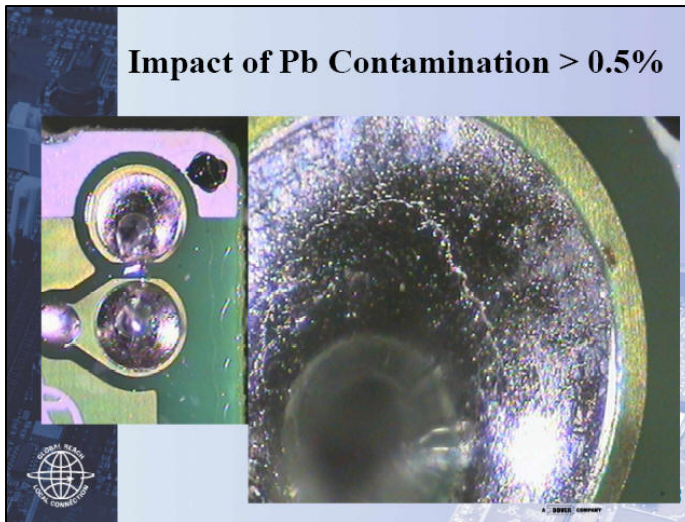
Lead-Free Assembly Process Challenges

Technical Challenges - Increased Temperatures



Lead-Free Assembly Process Challenges

Technical Challenges - Lead Contamination



Lead-Free Assembly Process Challenges

❁ Technical Challenges - BGA Compatibility

- ❁ BGAs in particular have compatibility issues and will pose reliability risks and defects if assembled using the wrong process, hence it is mandatory to control use of leaded parts in a lead-free process.
- ❁ If the wrong combination of solder paste and component spheres are used then the result will be unreliable joints
- ❁ Example below shows what happens when a tin lead sphere on a CSP is reflowed using lead-free solder paste. The large voids produced are unacceptable and pose reliability concerns.



Lead-Free Assembly Process Challenges

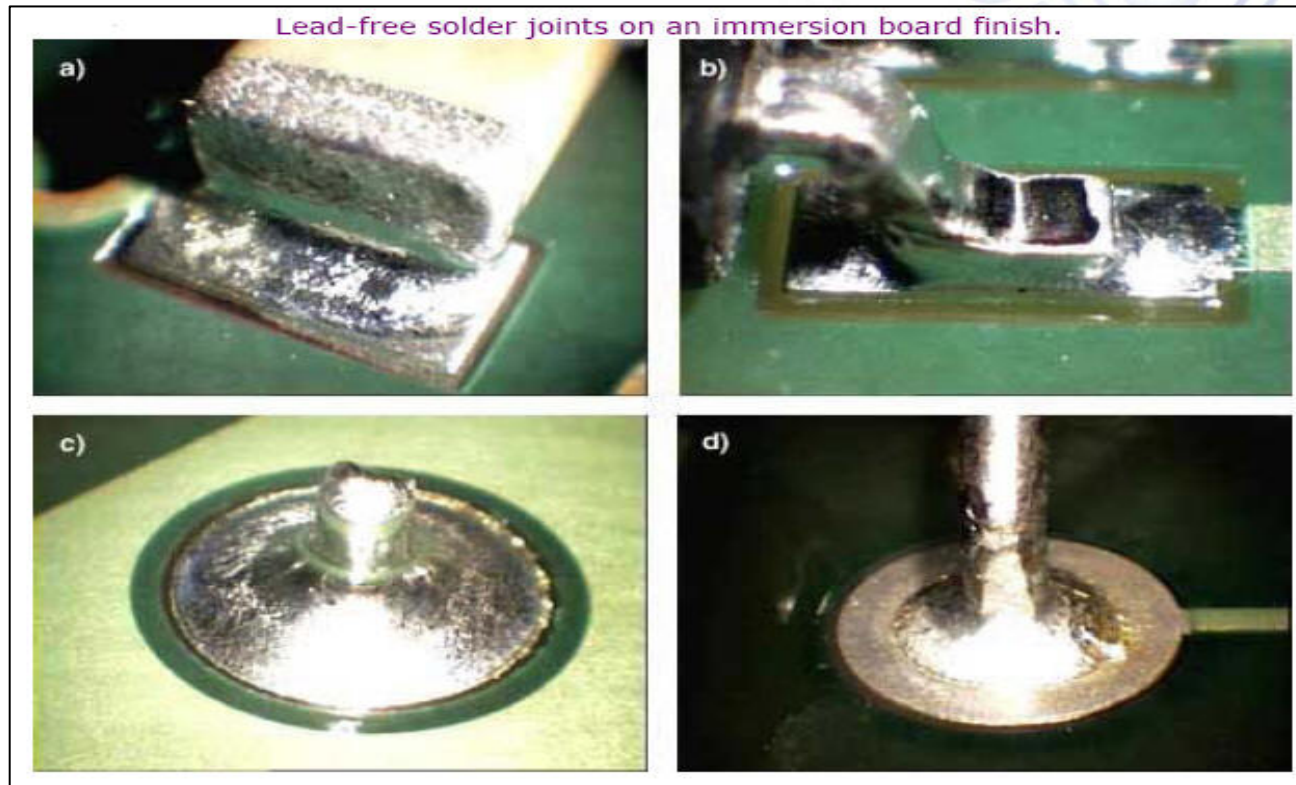
❁ Technical Challenges - Visual Inspection

- ❁ Industry visual inspection standards must be reviewed
- ❁ IPC-A-610D and J-STD-001D contain lead-free requirements
- ❁ Operators and customers must be educated on the visual appearance of good solder joints.











Lead-Free Assembly Process Challenges

Visual Appearance Differences



Lead-Free Assembly Process Challenges

Technical Challenges - Rework






-  Narrow process window due to higher heating requirements
-  Components must withstand 260 °C
-  NEMI Lead-Free Assembly and Rework Project
 -  NEMI Payette Reliability and Test Board
 -  All top edges of BGA components exceeded 245 °C
 -  Board temperatures at 150mil exceeded reflow temperatures (3 of 4)
 -  Difficult to duplicate profile in general industry use
 -  J-STD-001C implemented MSD recommendations from this project



Lead-Free Assembly Process Challenges

Technical Challenges - Industry Standards Update

IPC 610 - Rev D



-  Provides criteria where there is a difference between the 2 solder alloys:
 -  - Section 5 - Soldering
 -  - Section 6 - Terminal Connections
 -  - Section 7 - Through-Hole Technology
 -  - Section 8 - Surface Mount Assemblies

J-STD-001 Rev D

-  Contains specific lead-free content throughout the document

Re-certification of trainers and operators.

J-STD-020C & J-STD-033A

-  J-STD-020C contains some lead-free references.
-  Both standards expected to be updated by mid-2005 with lead-free material.



Lead-Free Assembly Process Challenges

✿ Technical Challenges - Assembly & Component Marking

- ✿ IPC-1066 (Jan 2005) and JEDEC JESD97 (May 2004) issued similar standards for marking lead-free assemblies and components.

Labeling for Pb-free 2 nd Level Interconnect	
e1	SnAgCu
e2	Other Sn alloys (ie. SnCu, SnAg, SnAgCuX, etc.) (No Bi or Zn)
e3	Sn
e4	Precious metals (ie. Ag, Au, NiPd, NiPdAu, but no Sn)
e5	SnZn, SnZnX (no Bi)
e6	Contains Bi
e7	Low temperature solder (<150°C) containing indium but no bismuth
e8, e9 symbols are unassigned categories at this time	
HF	Base resin and solder mask used making the bare board is halogen-free.

✿ Labeling categories defined in the standards

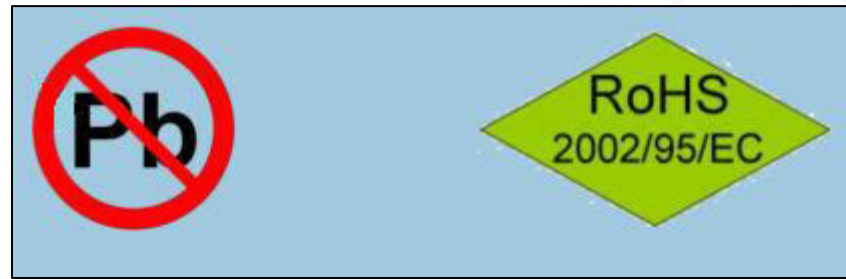
- ✿ Types of lead-free materials (solder finish)
- ✿ Maximum safe operation temperature during assembly
- ✿ Type of base resin due to halogen-free requirement (optional)
- ✿ Type of conformal coating (optional)



Lead-Free Assembly Process Challenges









❁ Technical Challenges - Assembly & Component Marking

- ❁ RoHS does not specify any labelling requirements
- ❁ Industry driven labelling for identification and marketing
- ❁ The RoHS label although perhaps not as easily recognised, does include all banned materials rather than concentrating on just lead.



Lead-Free Assembly Process Challenges

Process - Component Compatibility Issues

-  Many component manufacturers have already changed lead finish.
 -  Most finishes are compatible with both tin/lead and lead-free assembly.
 -  Migration to the use of these components is an ongoing process issue.
 -  Components are being used with only subtle changes to the visual appearance of the solder joints.
-  Some suppliers may have simply changed the termination plating without qualifying the component to the higher process temperatures
 -  It is important to ensure that they comply with general industry requirements.
-  Tin is the most common replacement for tin-lead but has some limitations
 -  Potential for tin whisker formation.






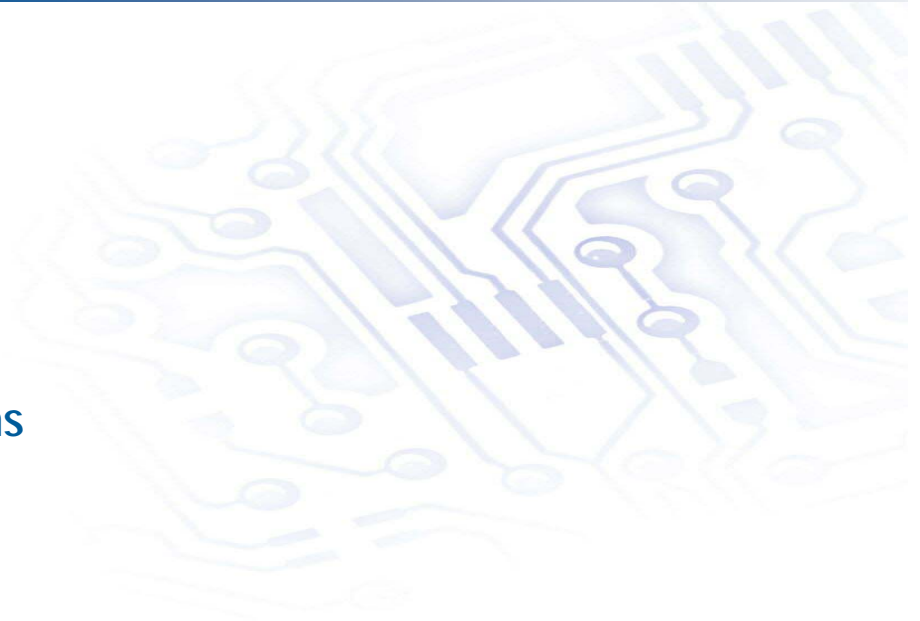
Lead-Free Materials & Components

Lead-Free Materials Considerations

-  Lead-Free Solder Alloys
-  Soldering Fluxes
-  Solder Pastes

Lead-Free Component Considerations

-  Board Surface Finishes
-  Board Materials
-  Component Issues



Lead-Free Alloys

- ✿ SnAgCu is the alloy of choice for all regions of the world at present.
 - ✿ True eutectic composition is SnAg3.5Cu0.9 (NIST)
 - ✿ Predominant SnAgCu alloy in use in Japan is SnAg3.0Cu0.5 and the trend is increasing elsewhere as well.
- ✿ IPC (SPVC) Recommendation
 - ✿ Sn96.5Ag3.0Cu0.5
- ✿ NEMI (USA) recommends:
 - ✿ SnAg3.9Cu0.6 for surface mount reflow soldering
 - ✿ SnCu0.7 for wave soldering



Lead-Free Alloys

Alloy Material Cost vs. Sn63Pb37*

Alloy Family	Relative Cost Ratio: Sn63Pb37 = 1
SnInAg(Bi)	3.3-3.5
SnAgCu	2.9-3.3
SnAg	3.1
SnAgBi(Cu)	2.4-3.1
SnBiAg(Cu)	2.1-3.1
SnBi	1.7
SnCu	1.5
SnZn(Bi)	1.4

* Note – cost is based on metals market price.



Lead-Free Printed Circuit Board Finishes

✿ Common board finishes to consider for a lead-free process

Board Finish	Comment
Electroless Ni / Immersion Au	Recommended in JEITA Pb-free roadmap and predominant in Japan and EU. Highest cost process, but good corrosion resistance for on-board contact pads and suitable for wire bonding pads for COB designs.
OSP	High volume, low cost alternative. Commonly used. Solderability more easily degraded by multiple reflows.
Immersion Ag	Good solderability and an increasingly significant board finish.
Immersion Sn	Commonly used in EU. Solderability with SnAgCu alloys is good.
HASL [SnAgCu or SnCu]	Minimal use in Japan.



Lead-Free Printed Circuit Board Materials

✿ Lead-free PWB Considerations

- ✿ Higher (compared to SnPb process) reflow and wave soldering temperatures.
- ✿ Excessive expansion in the z direction can endanger the reliability of through hole vias.
- ✿ Selection of a compatible laminate resin system is therefore essential.
- ✿ For standard thickness printed wiring boards (1.6mm) a material with a glass transition temperature of greater than 170°C is recommended as a minimum requirement.
- ✿ Thicker boards should be designed with laminate systems specifically developed for lead free compatibility. Designers should consult with bare board manufacturers to ensure that a suitable material is selected.



Lead-Free Component Issues

❁ Lead-Free Component Materials

- ❁ Component body materials: Temperature rating 260C peak/220C ninety seconds

- ❁ Identify and convert lower temperature rated materials
- ❁ How to handle components that can not be converted

- ❁ Avoid lead bearing finishes.

- ❁ Common Lead-free Finishes include:

NiPd	NiPdAu
SnB	Sn
SnCu	SnAg
Au	AgPt

- ❁ Identify and convert lead finishes
- ❁ How to handle components that can not be converted



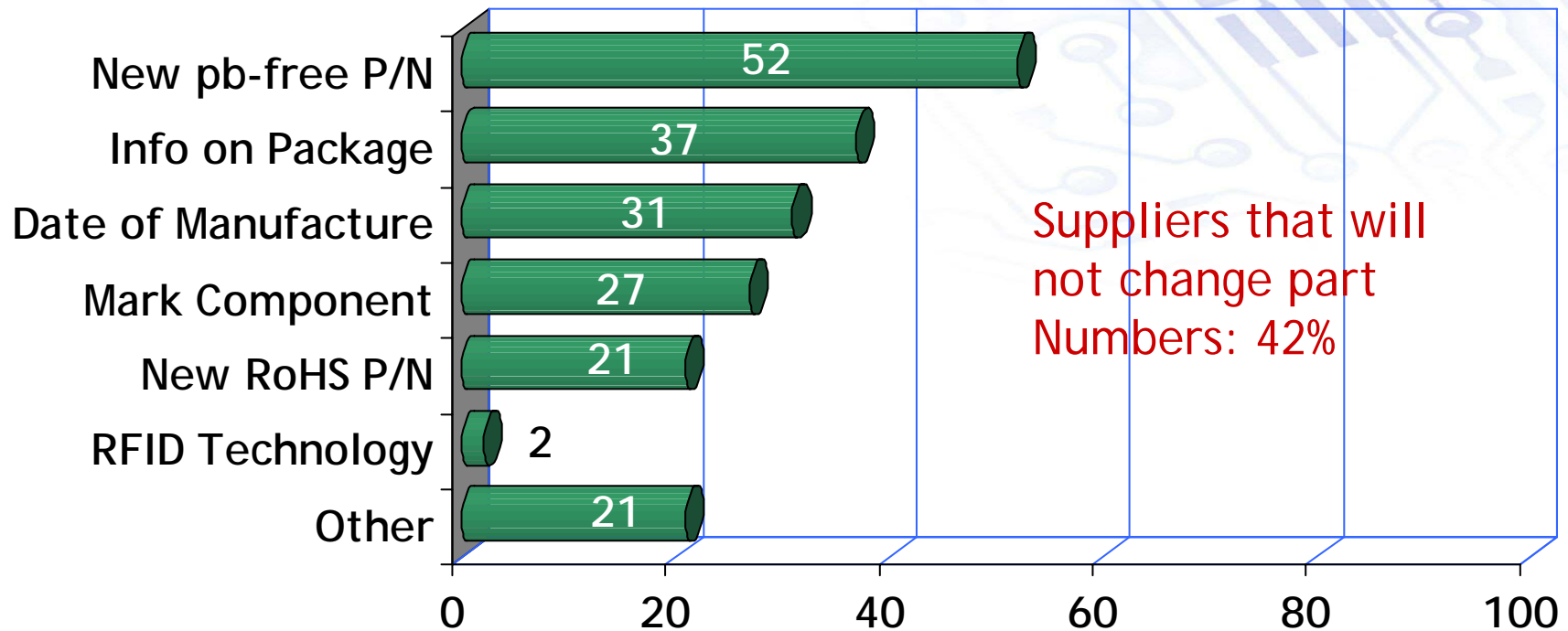
Lead-Free Component Issues

- ✿ Identification / marking of lead free components
 - ✿ How are Suppliers marking Lead-free components
 - ✿ New Part Numbers
- ✿ Inventory control/segregation Lead/Lead-Free
 - ✿ Separate Lead-Free & Sn/Pb stocking areas



Lead-Free Component Issues

Component Suppliers Part Numbering Plans



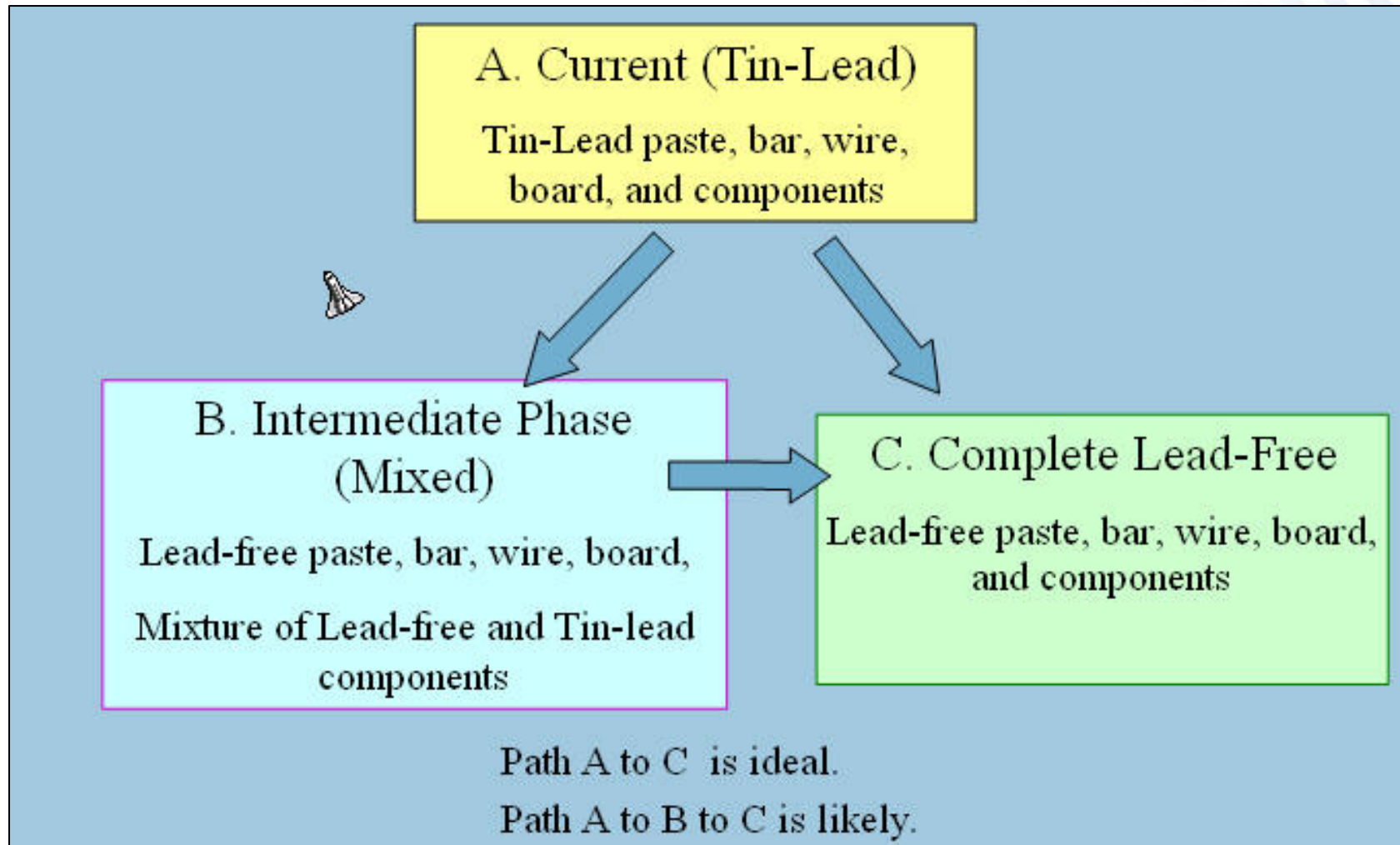
Lead-Free Component Issues

❁ Component Manufacturers & Suppliers Implementation Survey

Lead-Free Implementation Timeframe	Survey Results
Phase-out by the end of 2004 or prior	47
Phase-out by the end of 2005	8
Phase-out by the end of 2006	7
Customer request	8
No Plan	12
TBD	3
No Reply	18
Total # of Suppliers	101







CTS Lead-Free Transition



CTS Lead-Free Transition

CTS Lead Free Qualification Plan

Pb-Free Manufacturing Process Qualification

-  Process Qualification Began 1st Jan 2004
-  Test Vehicle Finalised
-  Will Qualify Both Assembly & Re-Work Processes
-  RoHS Compliance Verification Integrated into Design Review Process



CTS Lead-Free Transition

Test Vehicle - BOM

PCB 1
0.135" Thick
IS 410 (High Tg)
Immersion Silver Finish

PCB 2
0.062" Thick
IS410 (High Tg)
OSP Finish

Actives
PLCC 68
SOIC 40
POFP 160, 28 mm, 0.65 mm pitch
POFP 100
PBGA 256, 27 mm, 1.27 mm pitch
POFP 208, 28 mm, 0.5 mm pitch
DIP 16
SOT 23
SOT 89
µBGA 256, 17 mm, 1.0 mm pitch
CSP 208, 15 mm, 0.8 mm pitch
CSP 144, 0.8 mm pitch
CSP 96, 0.5 mm pitch
TSSOP 48
PLCC 44
TSOP 40, Type 1
TOFP 80, 0.5 mm pitch
SOIC 16
OFP 64 with heat slug, 0.5 mm pitch

Passives
1206 capacitor
0603 capacitor
0402 capacitor
Electrolytic capacitor, 10 mm
Tantalum D capacitor
0805 resistor
0402 resistor
0603 resistor
1210 resistor
2512 resistor
SO8 resistor
Resistor network, 8 pin 1.27 mm pitch
Resistor network, 8 pin, 0.5 mm pitch
34 pin post header connector
72 pin post header connector
DIMM socket , 278 pin, 1.0 mm pitch
Mictor SMT connector
2mm press fit connector



CTS Lead-Free Transition

✿ CTS Lead-free Qualification Plan

✿ Identify process consumables to be used in the qualification process

✿ Solder paste, Solder Bar & Repair Wire

- ✿ 96.5Sn3.0Ag0.5Cu

- ✿ Commonly referred to as "SAC 305"

✿ Wave flux & Rework Flux

- ✿ Choice based on specific process requirements



CTS Lead-Free Transition

✿ CTS Lead-free Qualification Plan

✿ Standards to which qualification samples are expected to comply.

- ✿ Visual Inspection to IPC-A-610D & J-STD-001D
- ✿ X-ray Inspection (2D) for bridging
- ✿ SIR Testing & overall cleanliness evaluation
- ✿ Cross-sectioning
- ✿ Dye & Pry Testing

✿ Methods to be used to verify compliance to the identified standards.

- ✿ Qualification Build Yield Metrics
- ✿ Qualification Test Metrics



CTS Lead-Free Transition

✿ EC Directive 200295EC (RoHS) Readiness

✿ Global Qualification Plan

✿ Scotland

Complete

✿ Singapore & California

Complete

✿ East Coast USA

Complete

✿ China

Complete

✿ Thailand


Complete




Summary

- ✿ Implementation of RoHS Directive will present significant challenges to both CTS and our customers
 - ✿ Board design considerations
 - ✿ Component selection and procurement
 - ✿ PCA assembly processes
- ✿ CTS is targeting all EMS facilities for qualification of lead-free process by Q4 2005





 For more information on how CTS EMS' lead-free programs can help you with your business requirements, please contact us using the following link:

 contact@is.ctscorp.com

