HUNTER
TECHNOLOGY CORP
Proudly Presents

Lead-Free Solutions

In Association with IPC & CCA

"WELCOME"

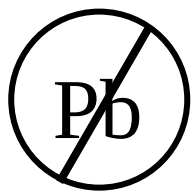
A Word Before We Begin

Please be aware that the statements contained in this presentation do not represent legal advice and are presented without any warranty as to accuracy.

This material represents our interpretation of the environmental regulations that have been passed, or are under consideration, in various regions throughout the world. Before acting on any of this information, you will have to verify the accuracy of Arrow's interpretation with your own legal counsel.

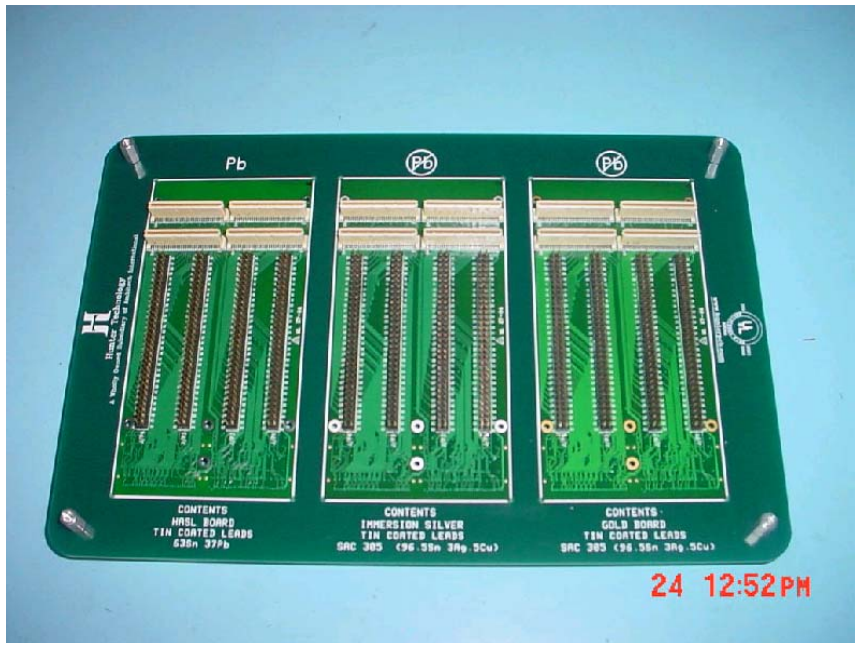
AGENDA

- Lead-Free, What is it? Why is it?
- Materials
- Equipment
- Procedures
- Questions and answers



LEAD-FREE EXAMPLES

Samples being passed around have 3 boards mounted in a pallet. Two of the boards are Lead-Free and one is assembled with lead. Notice the different look?



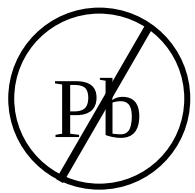
Note: the big end of the loupe goes towards your eye.

COMPONENTS

Arrow Electronics

It’s Time to Get the Lead Out!

Lead-Free Seminar



It’s Time to Get The Lead Out!

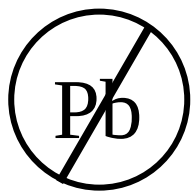
- **Overview**
- **Impacts and Sources of Complexity**
- **Actions at Arrow Electronics**
- **Key Take Aways**
- **Arrow’s Data and Services**

Overview: What are the RoHS/ WEEE Directives?

- **RoHS**: The European Union (EU) Directive on the **R**estriction **o**f certain **H**azardous **S**ubstances. This bans the use of certain substances, above the noted concentration levels in electrical and electronic equipment products.

Substance	Proposed Max Concentration
Lead – Pb	.1%
Mercury – Hg	.1%
Cadmium – Cd	.01 %
Hexavalent Chromium – Cr(VI)	.1%
Polybrominated biphenyls – PBB	.1%
Polybrominated diphenyl ethers - PBDE	.1%

- **Key Dates: Compliance by July 1, 2006.**



Overview: What is Exempt from RoHS?

- **Products for national security and military purposes**
- **The Auto Industry**
- **Lead in Cathode Ray Tubes and florescent tubes**
- **Certain steel, aluminum and copper alloys**
- **High end servers, storage and array systems**
- **Network and telecom infrastructure equipment**
- **Hexavalent chromium (in absorption refrigerators) Electronic ceramic parts**
- **Cadmium plating**
- **Mercury (in some lighting applications)**

Overview: What are the RoHS/ WEEE Directives?

- **WEEE:** **W**aste from **E**lectrical and **E**lectronic **E**quipment.
  Deals with the recovery, sorting and treatment of non-compliant products. WEEE looks to move, in part, the responsibility to the manufacturer-

  "Producer Responsibility"

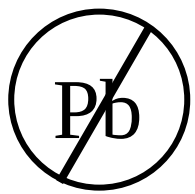
- **Products Affected:**
  - Household appliances, IT and telecommunications equipment, consumer equipment, lighting, electrical and electronic tools, toys, leisure and sports equipment, automatic dispensers.

- **Key Dates: Compliance by August 13, 2005.**

Overview: Additional Preliminary Legislation

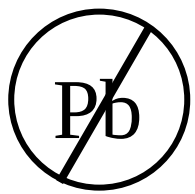
- **Japan:**
  - Voluntary compliance; Companies allowed to devise their own plan and most moving to lead-free voluntarily due to market pressures
- **China:**
  - RoHS-like legislation under consideration, no exemptions
- **US:**
  - No published federal position but EPA pressure, state activities

– California: As of 8/27/04 Senate Bill 50 signed by CA Senate and Assembly. If passed to law it will ban sale of non-RoHS compliant devices (with exemptions for components required by Underwriter Labs, Fed or State Gov.) as of 1/1/07.



Impact on the Supply Chain

- **Who is affected by the RoHS Directives?**
  - Anyone who manufactures or sells electrical and electronic equipment
  - Anyone who sells equipment produced by other suppliers under their own brand
  - Anyone who imports (or exports) affected equipment into European Union (EU) member states.

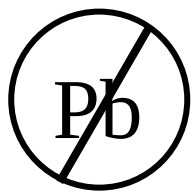


Impact on the Supply Chain

- **Can any domestic manufacturer ignore the impact of these regulations?**
  - Probably not.
  - As component suppliers develop RoHS Compliant versions of their components many will discontinue the original part.

Consider the economic feasibility for suppliers to continue with two versions of each component

  - Supply disruptions, particularly on leaded parts, may begin to occur at any time.
    - Many industry leaders believe the entire market will go completely lead-free



Impact on the Supply Chain

Regulations present tremendous complexity:

Variances in the timing of supply transition plans

Legislative "exemptions" cannot ensure stable supply

Evolving nature of environmental regulations

Differing manufacturing requirements make mixing of parts potentially unsafe

Variances in supplier policies

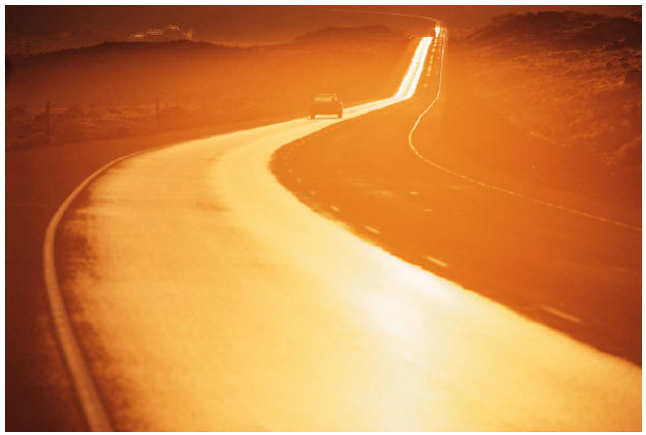
Sources of Complexity

- **Environmental regulations continue to evolve**
  - –Most are following guidelines established in RoHS

- **Variances in Supplier Timing and Policy:**
  - **Suppliers developing their transition plans and migrating to lead-free versions at very different rates**
    - It appears that most suppliers plan to complete the transition between Q2 & Q3 of 2005
    - We are already beginning to see an increase in EOL notices for leaded devices

  - – **Some suppliers are planning to transition to lead-free without changing the base part number**
    - -This makes the process of ordering, identifying and keep lead-free and leaded part inventories very difficult

Analysis of SEMI & PEMCO Suppliers



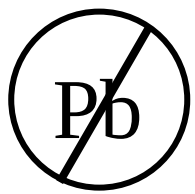
- 87% of NAC SEMI Suppliers have formulated their transition plans and policies
  - 72% of those SEMI Suppliers are changing P/N.

- 58% of NAC PEMCO Suppliers have formulated their transition plan and policies
  - 39% of these PEMCO Suppliers are changing P/N.

- Those suppliers not “rolling” part #s are typically indicating lead-free status through date codes, lot codes and package marking. Many communicating through e-PCN process

Sources of Complexity

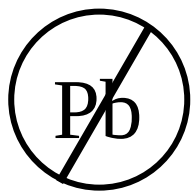
- **Manufacturing Concerns**
  - **Issue: Compliant parts don't mix well with non-compliant components**
    - Compatibility: Lead contamination on a lead-free solder joint could significantly reduce the reliability of the joint
    - Temperature: Lead-free alloys melt at higher temperatures (260º) than Tin-lead alloys (usually 235º)
    - When you switch to compliant parts both the components and PCB will need to withstand higher temperatures
    - Therefore, customers that replace Pb parts with Pb-free versions have to be sure that their manufacturing process is designed to handle higher temperatures



Sources of Complexity

- **Beyond Design: Material Management Concerns**

  - **Issue - The transition to lead-free has potential for serious impacts to pipeline management (Particularly when suppliers don't change their part numbers)**
    - Ordering and identifying lead-free parts in inventory; avoiding mixed inventory (which could lead to failures)
    - Managing MRPs to support existing product designs & manufacturing process with "leaded" parts until transition to lead-free design/process



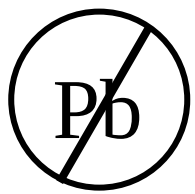
Arrow Electronics Actions

Overview:

- Formation of a Global Lead-free/ RoHS Task Force to begin assessing impact to Arrow and customer base
- Assisted in formation of NEDA position paper urging component suppliers to change part numbers when they release lead-free versions of parts
- Released lead-free and RoHS compliancy information on over 2.3 million parts through our component database
- Release of arrow.com lead-free research center

Ongoing:

- Communication with suppliers to collect information and to explain our position
- Identification of suppliers that are not changing part numbers



Key Take Aways

- You will be affected – don't be fooled by legislative exemptions
- Act now – a "Wait and See" attitude is very risky
- Appoint a Single Point of Contact
  - Monitor the evolving legislative landscape
  - Make decisions based on fact and not hype
  - Direct line to CEO or management with ability to effect cross- functional areas
- Consider challenges beyond design
  - Immediately assess a plan for ordering and identifying components if suppliers choose not to change the part number
- Understand your liability – work closely with your supply chain partners to develop a comprehensive plan

Component Selection and Management Services

ArrowRiskManager

Component Risk and BOM Assessment Tool

Featuring Global Explorer

ArrowAlert

Automated PCN's and EOL's

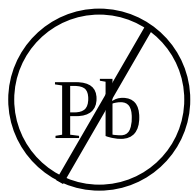
Powered by UBIQUIDATA

Arrow's proprietary component database

Lead-free and RoHS data is Now in CSMS!

As of mid–June 2004:

- 2.6 M parts have RoHS & Lead-Free data populated & growing weekly
- >60% Coverage on several key suppliers
- RoHS & Lead-free visible in Parametrics available via Risk Manager and Global Explorer
- Searchable, along with part parameters, in Global Explorer
- Available in the Find Similar Feature
- Visible in Cross Reference Feature
- Receive Lead-free Alerts by selecting Environmental Data/Other category
- Datasheets always available
- Identify parts on Master List containing lead or not RoHS compliant, by limiting search in Global Explorer to Master List parts



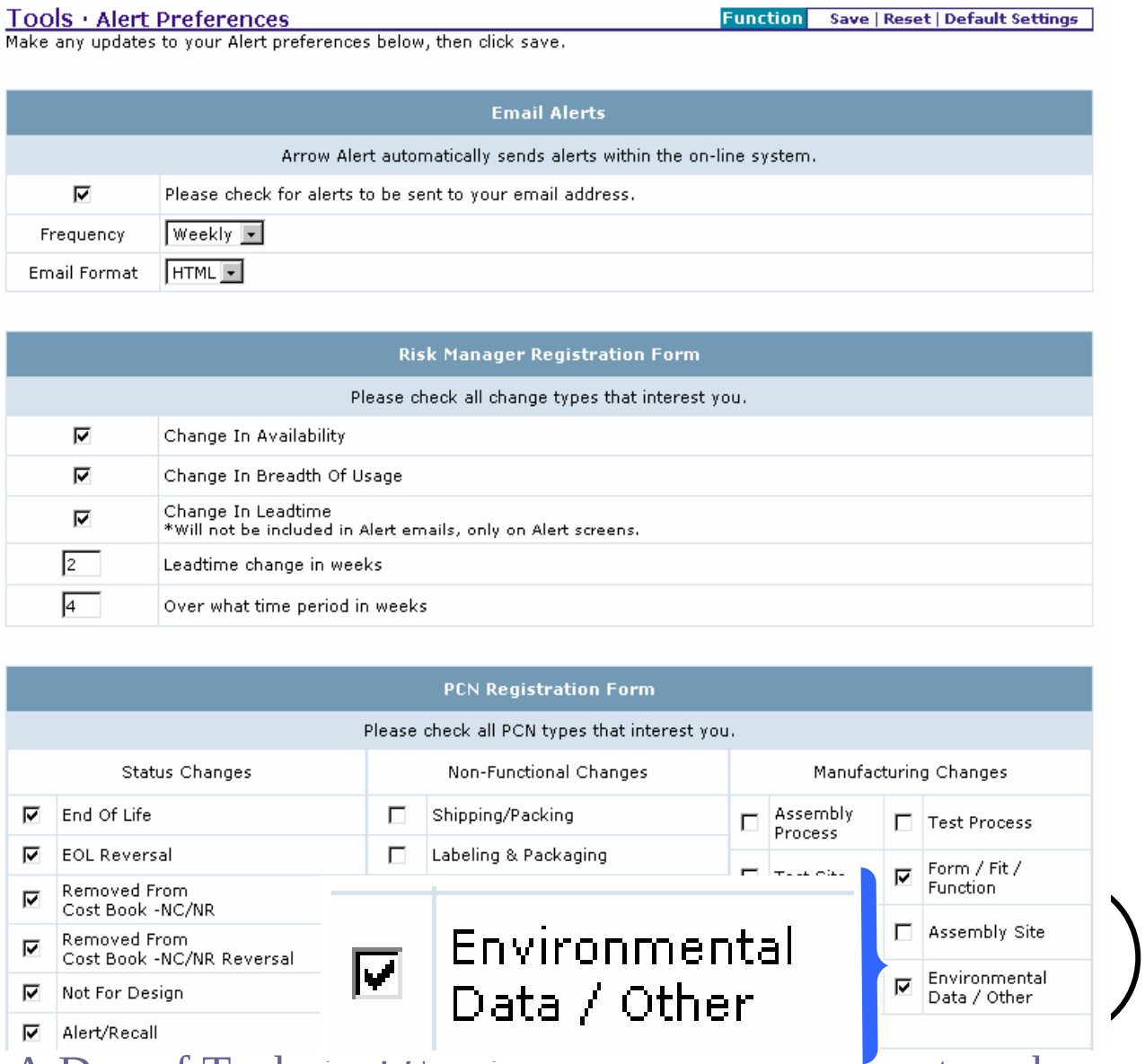
Using CSMS to Help Achieve Compliancy

Steps to identify non-compliant components:

- Identify non-compliant parts on Master List (AVL)
- Search for replacement parts using the following:
  - Cross Reference
  - Find Similar
  - Compare (Parameters) in Global Explorer
  - View complete part datasheet

Awareness as Suppliers Confirm Compliancy

- Utilize the CSMS tool for proactive change notifications…
- Elect to receive email Alerts as Suppliers provide environmental compliancy change detail



Tools · Alert Preferences — Function: Save | Reset | Default Settings

Make any updates to your Alert preferences below, then click save.

Email Alerts

Arrow Alert automatically sends alerts within the on-line system.

- ☑ Please check for alerts to be sent to your email address.
- Frequency: Weekly
- Email Format: HTML

Risk Manager Registration Form

Please check all change types that interest you.

- ☑ Change In Availability
- ☑ Change In Breadth Of Usage
- ☑ Change In Leadtime *Will not be included in Alert emails, only on Alert screens.
- 2 Leadtime change in weeks
- 4 Over what time period in weeks

PCN Registration Form

Please check all PCN types that interest you.

Status Changes	Non-Functional Changes	Manufacturing Changes
☑ End Of Life	☐ Shipping/Packing	☐ Assembly Process
☑ EOL Reversal	☐ Labeling & Packaging	☐ Test Process
☑ Removed From Cost Book -NC/NR		☑ Form / Fit / Function
☑ Removed From Cost Book -NC/NR Reversal		☐ Assembly Site
☑ Not For Design		☑ Environmental Data / Other
☑ Alert/Recall		

☑ Environmental Data / Other

Lead-Free Arrow Email Alert

Sample E-mail Alert

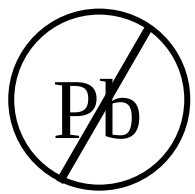
From: arrow-csms@arrow.com [mailto:arrow-csms@arrow.com]
Sent: Monday, October 20, 2003 5:05 AM
To: dsmith@bigcompany.com
Subject: Your Weekly Part Change Alerts From Arrow Electronics, Inc.

==========
Period from October 13, 2003 to October 20, 2003
==========
****
* End of life and Recall Alerts *
****

No Alerts To Report.

****
* Part Change Alerts *
****

Customer Part Number: 123X-XD
Supplier Part Number: SN74AHCT1G08DCKR
Manufacturer: Texas Instruments
Issue Date: October 6, 2003
Effective Date: November 15, 2003
Type Of Change: LEAD FREE
Recommended Replacement:
Description Of Change: Texas Instruments Standard Linear and Logic (SLL) is pleased to announce the~successful qualification of the 5 and 6 pin DCK package using the NiPdAu lead~-free lead finish. All Texas Instruments internal assembly/test facilities are~currently manufacturing SLL products with the NiPdAu (Pb-free) lead finish.
Projects Affected: My BOM



On-Line (Environmental) Supplier PCNs

Provides Access to the Actual Supplier Notification

New Change Notice

Group Name: Arrow Material Planners

View Projects Affected

Customer Part Number	Supplier Part Number	Supplier Name
	SN74AHCT1G08DCKR	Texas Instruments

PCN Issue Date	PCN Effective Date	Last Time Buy Date	Supplier PCN
10/06/20			

Type of PCN

LABELING AND PACKAGING, LEAD FREE

Description of Ch

Texas Instruments Standard Linear and
successful qualification of the 5 and 6
-free lead finish. All Texas Instrumer
currently manufactur ing SLL product

Supplier Defined Impact of Ch

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TEXAS INSTRUMENTS

Final Notification for the Pb-free Lead Finish Qualifications SLL External Manufacturing Sites

October 6, 2003

Abstract

Texas Instruments Standard Linear and Logic (SLL) is pleased to announce t
qualification of the 5 and 6 pin DCK package using the NiPdAu lead-free lead fini
Instruments internal assembly/test facilities are currently manufacturing SLL proc
NiPdAu (Pb-free) lead finish.

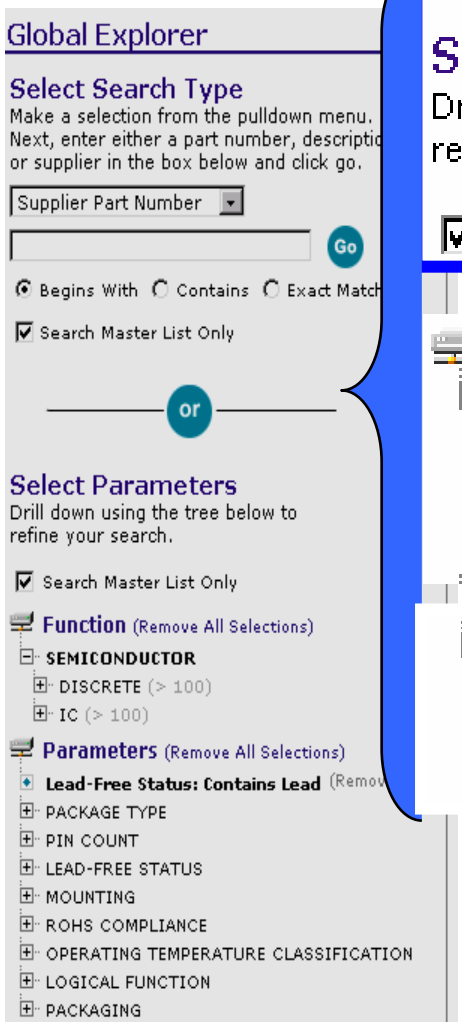
Analysis

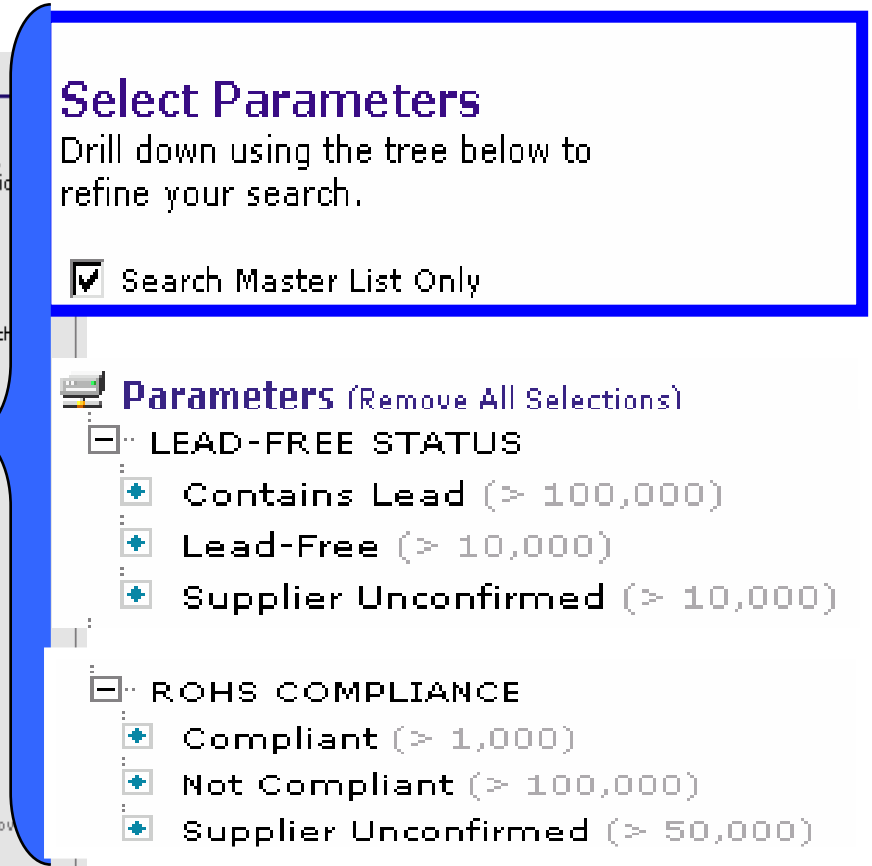
Pb

Identify Non-Compliant Parts on Your AVL

- **Search Master List Only**
- **Select "Contains Lead"**
- **All Non-compliant parts on the AVL are returned**

- **Note: Searches can be performed on Lead-free or RoHS compliance**





Summary:

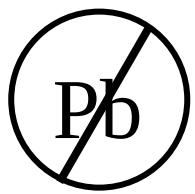
Get Ready for Changing Environmental Regulations

- Begin immediately to get internal processes and systems in place - Don't risk losing market share through lack of preparation
- Be Informed – Understand the initiatives that may impact your operations
- Define Support Processes – Identify who is responsible to track / transition components to compliance
- Evaluate your Applications – Are your existing data systems up to the challenge?
- Identify Affected Products – Arrow's CSMS Suite can help you analyze your BOMs, identify non-compliant components and find suitable alternatives.

Printed Circuit Board Finishes

Surface finishes considered most compatible with Lead-Free processes are:

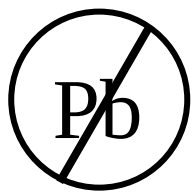
- **ENIG/NiAu** (Electroless Nickel/Immersion Gold & ElectroPlated nickel Gold)
- **IAg** (Immersion Silver)
- **OSP** (Organic Surface Protectant)



ENIG/NiAu (Electroless Nickel/Immersion Gold & ElectroPlated Gold)

- Pro's
  - Long shelf life
  - Good for multiple thermal cycles (soldering)
  - Well established and documented process
  - Good Co-Planarity

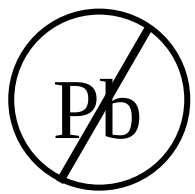
- Con's
  - More expensive
  - Gold contaminates the solder joint
  - Nickel has some electrical properties that can adversely affect RF boards



IAg (Immersion Silver)

- Pro's
  - Fair for multiple thermal cycles (soldering)
  - Good Co-Planarity
  - Costs about as much as HASL

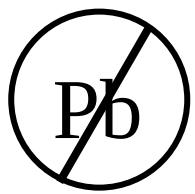
    Easy to rework
- Con's
  - Some handling issues (sensitive to Sulfides)
  - Short shelf Life
  - Non-soldered joints will oxidize
  - Required to be stored in sulpher-free paper



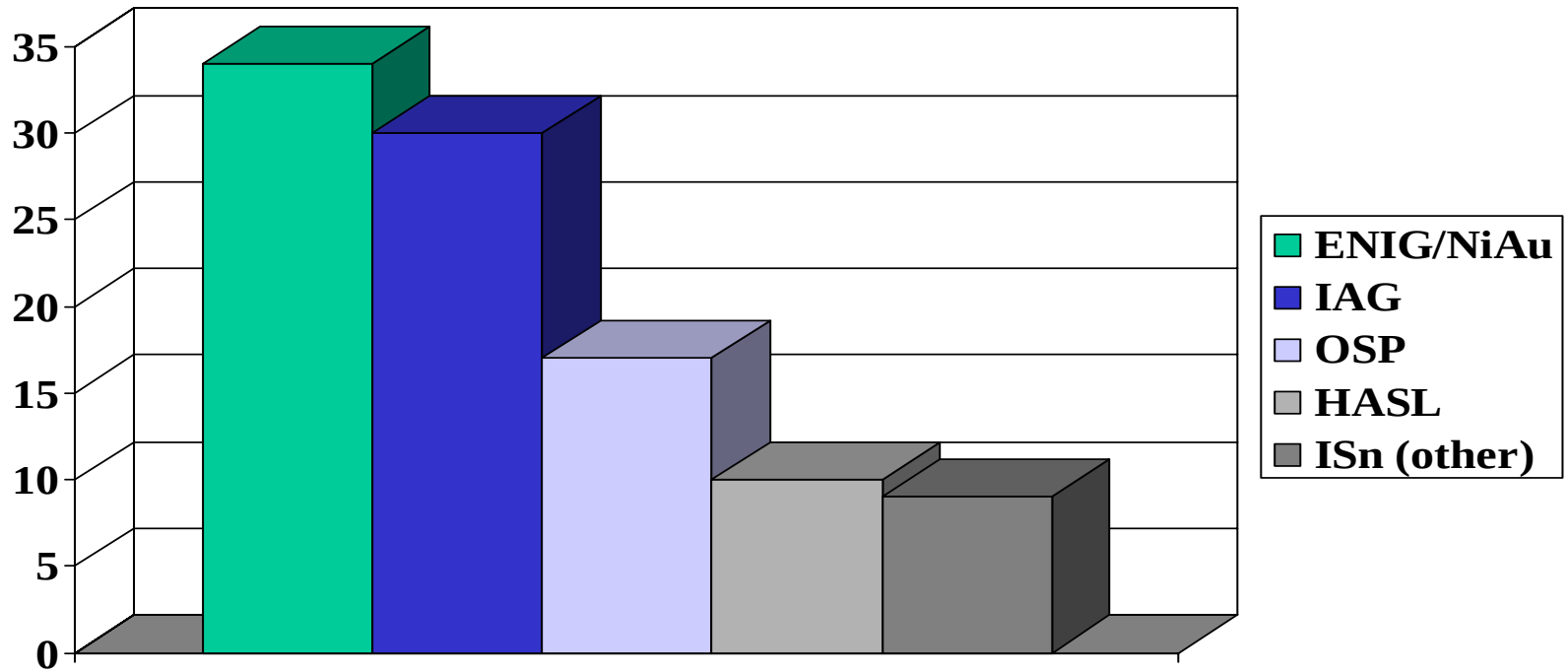
OSP (Organic Surface Protectant)

- Pro's
  - Good for high volume JIT work
  - Good Co-Planarity

- Con's
  - Not as good for multiple thermal cycles (soldering)
  - Hard to inspect
  - Not as good shelf life
  - Tendency for incomplete hole fill
  - Can cause problems during pin test
  - Handling – Gloves are a must

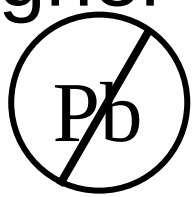


Surface Finish Usage Projections for 2006



PCB LAMINATE

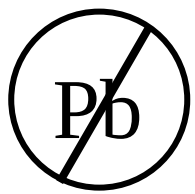
- Laminate concerns due to higher assembly temperatures
- Higher temperature typically insignificant in terms of change in electrical properties
- Standard FR4 may continue widespread use with some upper limits
  - High layer count – Z expansion
  - Larger PCB size – Warpage
- Over & above these limits may warrant higher Tg laminates



Lead Free Really Lead Free?

- Not necessarily true.
- There are some exceptions and allowable limits.
- One Directive allows .1% lead and still call it lead-free.

There are some specific assemblies, like some backplanes and military assemblies that may never be approved to be lead-free.



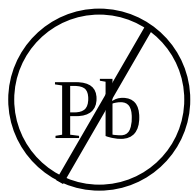
IPC RELIABILITY STUDY

Solder **P**roducts **V**alue **C**ouncil

Goal: **Reduce the confusion regarding alloy choice and is devoted to achieving a worldwide consensus on the issue.**

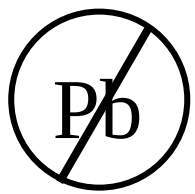
IPC SPVC Lead Free Research Members

- Aim, Inc.
- Amtech, Inc.
- Avantec
- Cookson Electronics Assembly Materials
- EFD, Inc.
- Harimatec
- Henkel Technologies
- Heraeus, Inc.
- Indium Corporation
- Kester Solder
- Koki Company
- Nihon Superior
- P. Kay Metals, Inc.
- Qualitek Int., Inc.
- Senju Metal Industry
- Shenmao Tech.
- Thai Solder



Lead Free Subcommittee

Selecting one “default” lead-free alloy benefits everyone in the supply chain.



SOLDER ALLOY

The most common Lead-Free alloy of choice is

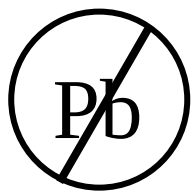
Sn (tin) **+ Ag** (silver) **+ Cu** (copper)

Commonly called a ***SAC*** alloy because

it's constituents are : ***S***n / ***A***g /***C***u.

Melting point of around 217C (183C for Sn/Pb).

SAC's exhibit good reliability and solderablity

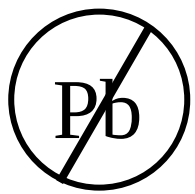


ALLOY TERMINOLOGY

SAC305 = **Sn 3.0%Ag** 0.**5%Cu**

SAC387 = **Sn 3.8%Ag** 0.**7%Cu**

SAC405 = **Sn 4.0%Ag** 0.**5%Cu**



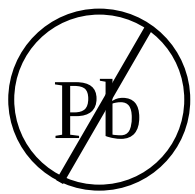
IPC ALLOY STUDY

- IPC performed SAC alloy reliability testing.

  Compared Three tin/silver/copper "recipes":

  - 96.5Sn/3Ag/.5Cu
  - 95.5Sn/3.8Ag/.7Cu
  - 95.5Sn/4Ag/.5Cu

  with a 63Sn/37Pb control



IPC RESULTS

The results of the Reliability Testing?

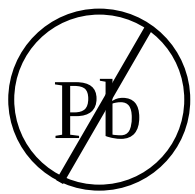
"**No significant difference was found between the four pastes used."**

Use the SAC you are most comfortable with (have most experience with?)

FLUXES

Both water soluble and no-clean fluxes are available in lead-free formulas.

Fact: Little impact if flux can handle elevated temperatures without being“Baked on” and becoming difficult to clean, if cleaning is required. Must also be suitable for longer/lower ramp rates.



EQUIPMENT

Stencil Printer

Pick and Place Machine

Reflow Oven

Wavesolder Machine

Board washer

STENCIL PRINTER

- Most good quality stencil printers are

  Lead-Free capable.

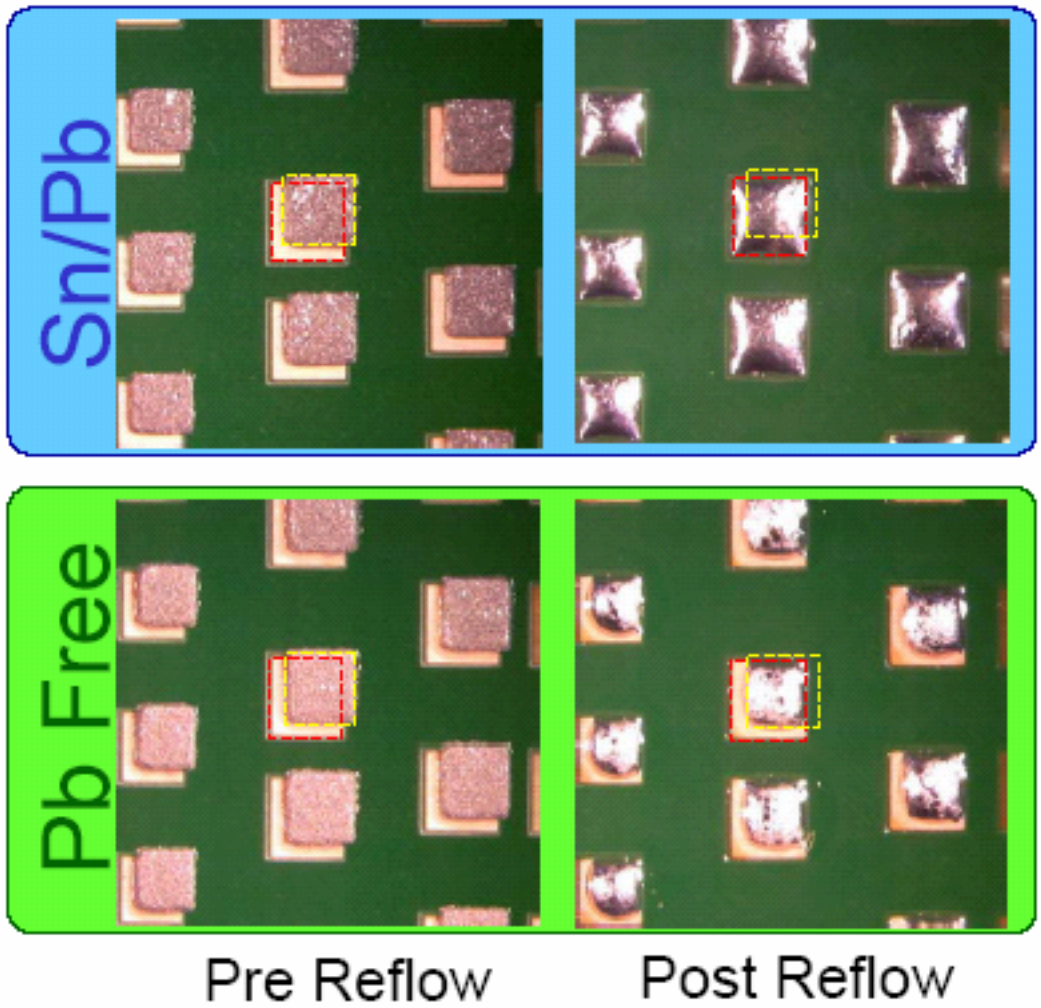
  Good alignment is required because of the poor spreading characteristics of Lead-Free solder

PRINT ALIGNMENT

Example of how Lead-Free solder does not

"pull-in" to the pads.

This also show the limited ability of Lead-Free solder to spread



PICK & PLACE

- Just about any machine manufactured in the last 5 years is acceptable

REFLOW OVEN

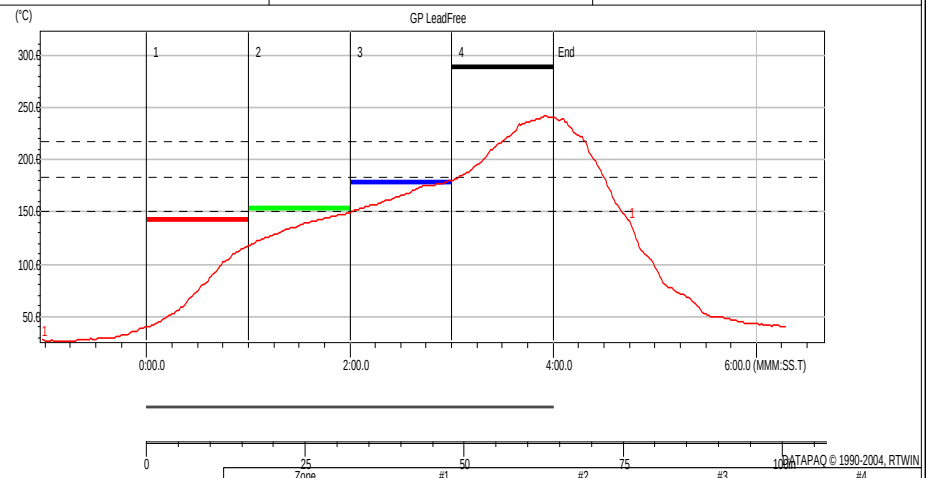
- Because of the increase in heat and longer/lower slope rates from Lead to Lead-free solder, longer machines and more zones may be required

PROFILING

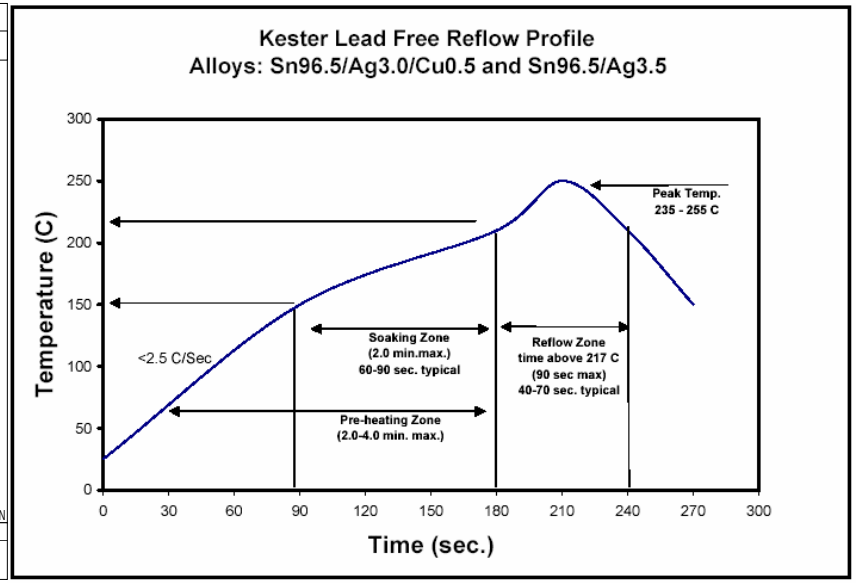
- Sample's Profile

Recommended Profile

Company	Hunter Technology Corp.	Process	OVEN 1	Printed	09/25/2004
Site	Cambridge	Product	PR2001-E	Line Speed	16.0 (in/min)

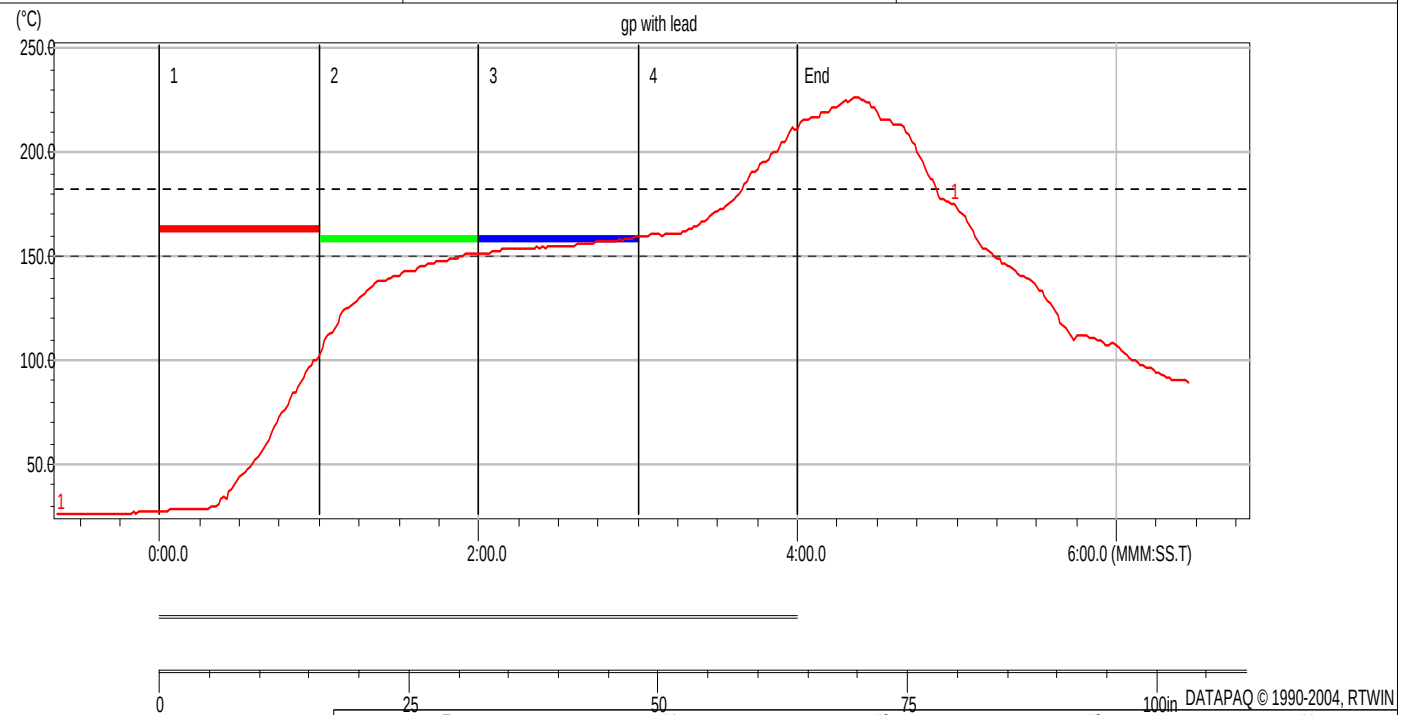


Speed 16.0 (in/min)	Zone	#1	#2	#3	#4
	Upper	145	155	180	290
	Lower	145	155	180	290



Profile of samples with lead

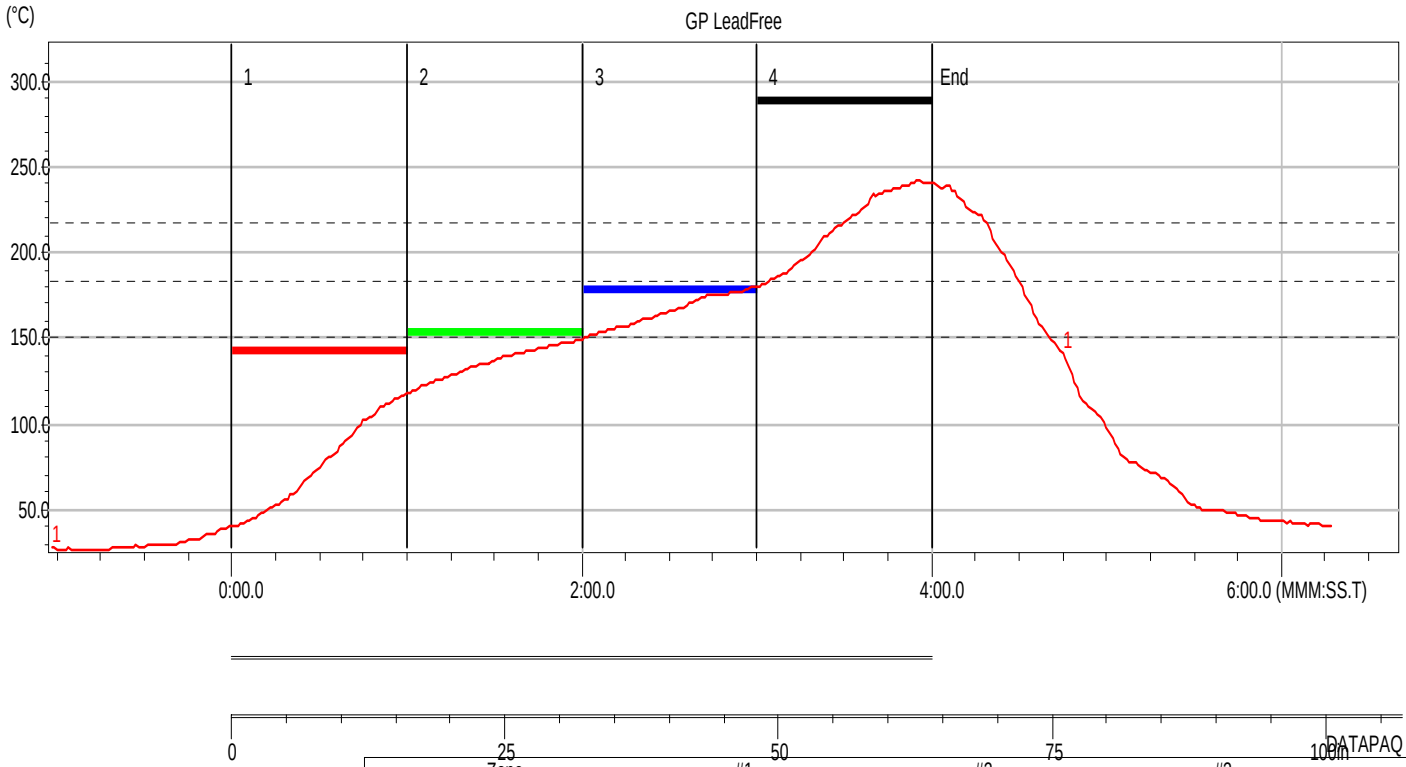
Company	Hunter Technology Corp.	Process	OVEN 1	Printed	09/25/2004
Site	Cambridge	Product	PR2001-E	Line Speed	16.0 (in/min)



Speed	Zone	#1	#2	#3	#4
16.0 (in/min)	Upper	165	160	160	260
	Lower	165	160	160	260

Profile for samples w/o lead

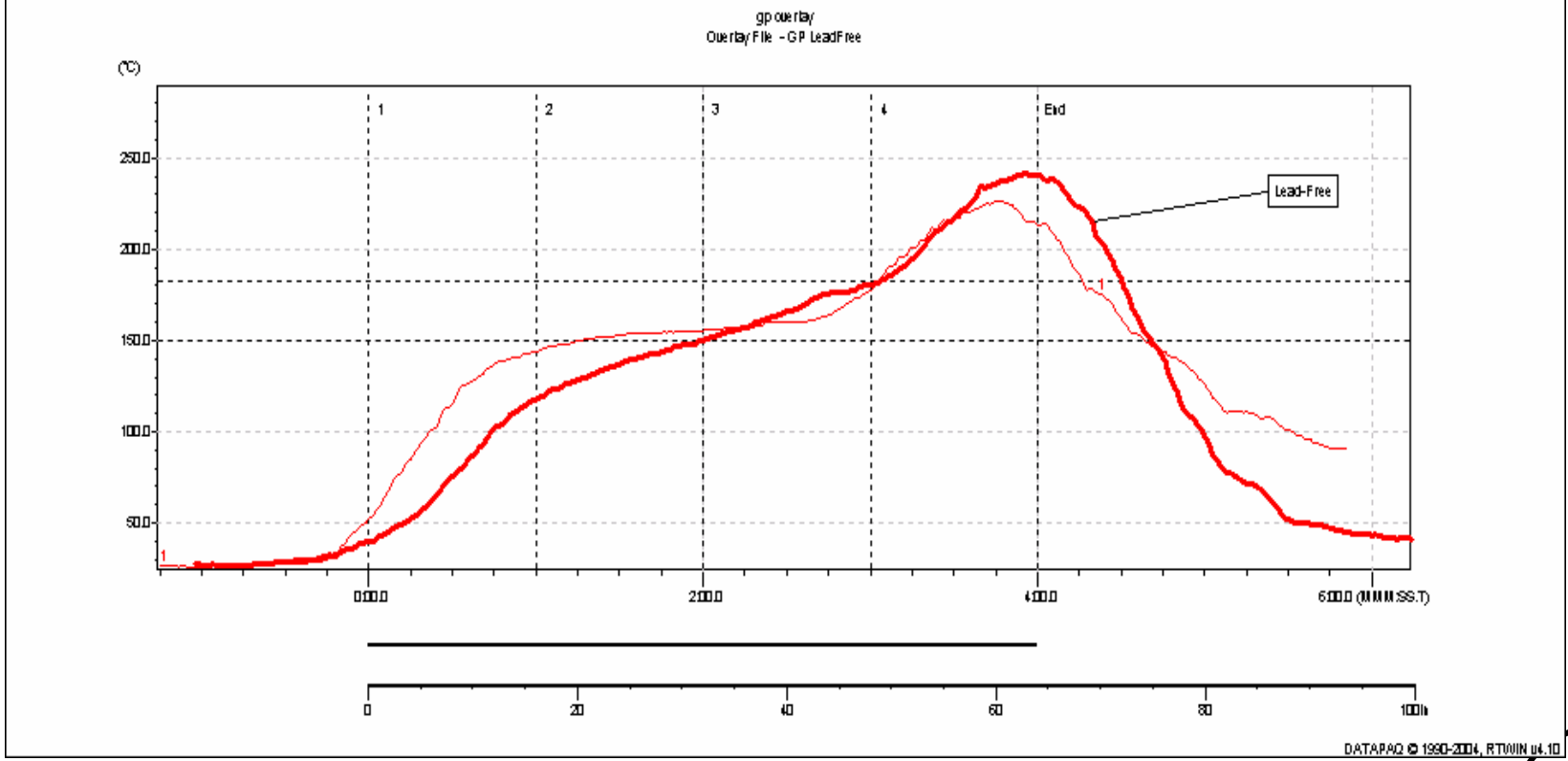
Company	Hunter Technology Corp.	Process	OVEN 1	Printed	09/25/2004
Site	Cambridge	Product	PR2001-E	Line Speed	16.0 (in/min)



Speed	Zone	#1	#2	#3	#4
16.0 (in/min)	Upper	145	155	180	290
	Lower	145	155	180	290

Sample Profiles Compared

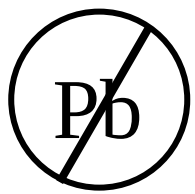
Company	Hunter Technology Corp.	Process	OVEN 1	Printed	09/25/2004
Site	Cambridge	Product	PR2001-E	Line Speed	16.0 (in/min)



WAVESOLDER

- The solder pot must be capable of reaching 280C
- The solder pot and internal parts must be protected against the corrosion caused by the high-tin content of the Lead-Free solder.

Otherwise expect erosion in less than 9 months. **<u>Do Not</u> Intermix lead and lead-free solders.**



BOARD WASHER

- Current board washing technology is suitable. If the machine is capable of cleaning under MicroBGA's it can do the job. Baked on fluxes will present a challenge

REWORK

- BGA rework must also implement Lead-Free type profiles.

  Most quality rework systems are acceptable

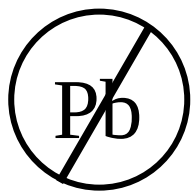
SOLDERING IRONS

Soldering irons may require slightly more time to make the solder joint.Current irons (with the proper tips) have the thermal capacity to do the job. Larger ground planes and heavy mass components may create problems here

Inspecting?

Inspection equipment stays the same. But the inspection criteria must change to accept things that would be perceived as “reject able” in a lead process. Training will be required for the inspectors to inspect Lead-Free.

IPC is set to roll out an updated IPC 610 to reflect to Lead-Free workmanship standard changes in the next few months.



PROCESSES

Processes Impacted?

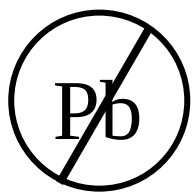
Printing? Little change

Placing? Little change

Reflowing? Increase in Temperature and time.(Profile)

Waving? Higher temps both solder pot and preheat section

Inspecting? Slight change in acceptance criteria



ACCORDING TO IPC J-STD –001C

“

9.2.4 SOLDER CONNECTION

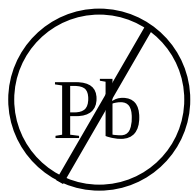
Solder shall indicate evidence of wetting, forming a contact angle of 90° or less

Solder should have a generally smooth appearance

Satin luster is permissible

Some solder alloys, board platings, soldering processes produce dull, matte, gray, or grainy solder that are normal and acceptable

“



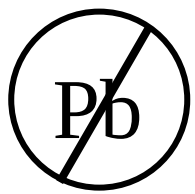
SOME REMAINING ISSUES

Keeping from co-mingling Lead and Lead-Free assemblies and materials. Both processes may share common pieces of assembly equipment .

Indicate which SAC alloy was used?

How does Hunter control? All build packages include solder information:

Manufacturer, type of solder, lot number and expiration date.



QUESTIONS?

- Any questions?
- Any answers?
- Any suggestions?

HUNTER TECHNOLOGY CORP

Proudly Presents

Lead-Free Solutions

In Association with IPC & CCA

“Thank You!”