

PACE Worldwide lead-free Web Information

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The lead free initiative

For many players in our industry, the time has come to implement lead-free processes. An understanding of the lead free initiative will help you integrate lead-free products and techniques into your workplace. The European Union has been driving the lead-free initiative. The EU directives have been established to regulate/limit certain hazardous materials that are used in manufacturing. The RoHS, (Restriction of (certain) Hazardous Substances) and WEEE (Waste Electrical and Electrical Equipment) are an attempt to remove lead (Pb), cadmium (Cd), mercury (Hg), chromium (Cr) and bromine (Br) from electronics products and waste. The electronic industry uses less than 0.5% of lead in the production of PCB's and components while battery manufacturers consume 85% and have been exempted from the regulation. Effective July 2006, all electronic products imported to or exported from EU countries must meet the RoHS and WEEE standards.

Currently the United States has no federal restrictions but many of these substances are also restricted under individual state law, such as California's Proposition 65. A few states have implemented "E-Waste" recycling efforts to reduce the amount of waste electronic materials destined to end up in landfills. Privately owned companies have seized the opportunity to disassemble, sort, and reclaim materials both harmful and useful from obsolete devices. The goal of removing lead from electronics is intended to reduce the amount of harmful materials that end up in landfills every year. Much of which may have unforeseen environmental effects if leached into ground water. However, when we compare the benefit of eliminating 0.5% of the annual lead production from reaching landfills (and the amount of lead that actually leaches from solder alloys is marginal) and the huge cost of forcing the electronics industry to use a marginal, undesirable product and to re-develop all of its existing manufacturing processes, one has to ask if its truly worth the cost?

How do the regulations abate the problem?

Controlling the flow of restricted materials is based on compliance. Evidence of compliance will only be required if an enforcement authority asks for it, but they will expect to see evidence that the producer has taken what will be regarded as "reasonable steps" to comply with legislation. If the "producer" imports electrical and electronic equipment into the European Union then, in theory, he would ask his supplier for a declaration that that the equipment complies. If the producer assembles equipment within the EU, then he should obtain a declaration for all the parts, components and materials he uses and this information would be stored in a technical file. One certificate or declaration is enough for each class or type of component, for example all chip resistors of one type irrespective of

size or value could be covered by one declaration as long as they have similar composition and all are RoHS compliant.

What's going on in Asia?

In Japan there are no explicit laws or decrees which in electronic products restrict the use of lead and lead-containing connections. Concerning the disposal of electric and electronic waste products Japan encourages the recycling of the appliances. Substances which can be re-used as raw materials are to be removed and reused or used for thermal recovery. The major manufacturers in Japan have voluntarily begun to implement lead-free programs, even though legislatively, there is no compelling reason to move forward with it.

In China procedures for the Administration of Pollution Prevention and Control in the Production of Electronic Information Products (Article 11) require manufacturers to restrict the use of the same substances targeted by Europe in certain consumer electronic products. In China a WEEE-like legislation is being prepared. A draft version was published on 17th September 2004. Already now the illegal import of WEEE from countries like Japan and the USA is prohibited selectively. China's law draft is similar to the RoHS but lacks many of the exemptions provided in the EU laws.

Why are European and Chinese standards affecting manufacturers in North America?

Any company that manufactures in, or exports to the European Union will be required to comply with the WEEE and RoHS directives by specific dates in the near future (August, 2005 for WEEE and February, 2006 for RoHS). Any manufacturer that fails to do so will have its products banned from sale in EU member countries. Similar requirements are expected from China soon. With market globalization and centralization of manufacturing in low cost labor regions, it is prudent that one process be selected for manufacture that will go into all products. Since lead-free will be required in the EU and China, it is only practical from a manufacturing perspective that all manufacturing move to lead-free processes.

[Working with lead-free products](#)

Lead-free solders do not behave or look like their lead containing counterparts. As our industry changes over to lead-free solders, individual PCB assemblers will need to address several issues relating to hand soldering and rework. These issues include:

- **Higher melting temperatures** which mistakenly lead to operators increasing equipment operating temperatures. Higher operating

temperatures do not make the process quicker, they actually slow it down.

- **Poor wetting and spreading properties** – Additional time is required when working with lead free solders, they do not spread or wet like lead containing solders do. Operators must slow down.
- **Difficult to work with** - Bridging and insufficient solder defects are common, even for experienced operators, leading to operator frustration.
- **Dull grainy finish** – makes inspection difficult.

Because lead free solders oxidize quickly, more aggressive and longer lasting fluxes are required to keep surfaces clean and free from oxidation. Working with no-clean fluxes is challenging as their process window is often small. Once they are burned off, oxidation immediately begins to form which can result in a marginal or defective solder joint. Additionally, increasing operating temperatures creates an ideal environment for oxidation to form and will also lead to flux and solder ball splatter on the PCB. If the flux is splattered all over the PCB, it's not able to do its job on the surfaces to be joined during the soldering process.

Lead Free solders also affect soldering and rework tools and their effect is detrimental. Lead free solders contain high percentages of tin, almost always over 94%. Tin is a corrosive and active metal. When it mixes with iron (the protective layer on soldering tips), an inter-metallic compound is formed that wears away more quickly than the iron would either by itself or when used with lead containing solder. This causes two problems, one is shorter tip life as the protective iron coating is dissolved in the tin, and the second is that oxidation forms more quickly which is further exacerbated by the high temperature environment the tips work in. As a result, tin oxides form and create an inter-metallic compound with the iron plating on the tip. Once the oxidation begins to form, the tip will lose its ability to wet with solder and if not cleaned off quickly, it becomes almost impossible to remove and the tip must be replaced.

When using lead-free solders, regardless of alloy, it is absolutely imperative that tips are properly maintained, otherwise tip life will be reduced significantly. Tips should be cleaned frequently to remove oxidation before it becomes impossible to remove. Tips should always be tinned when placed not being used, otherwise oxidation will quickly form on the tip. If the iron will not be used for extended periods of time, they should be turned off. Should oxidation form that can not be easily cleaned by tinning or by using a cleaning tool, Sodr-Tek's Tip Brite is recommended. Tip-Brite is a high quality tip tinner that will remove stubborn oxidation.

The use of equipment with setback and auto-off functions (standard on all PACE equipment), is very desirable. Additionally, optional accessories such as PACE's Instant Setback Cubby ensure that tip life is maximized. The instant-set back

cubby puts the system into “Setback” after 45 seconds of inactivity. When the iron is removed from the cubby, it restores itself to the set temperature almost immediately.

The use of nitrogen assisted soldering equipment helps to mitigate the problems associated with using lead-free solders. Nitrogen helps on two fronts. First, it creates an inert environment around the soldering tip, reducing the potential for tip to oxidize. Second, it assists in the soldering process at the PCB level by purging oxygen from the immediate area which reduces or eliminates the formation of oxidation from the work site. This not only reduces the amount of flux that is required, but it also helps to improve wetting, spreading, and leaves a finish that is shinier and less grainy.

PACE’s nitrogen assisted soldering systems pass the nitrogen through or around the heater before it is directed to the work site. This “preheats” the immediate area which can also help to reduce thermal shock to component leads and to components themselves. Pre-heating also allows for the use of lower, safer, and more effective soldering temperatures

Lead-Free Solders

Alloys used in lead-free solder can vary widely. The most common alloy used is the tin, silver, copper alloy. Mixtures of either 96/3.5/.5% or 96.5/3/.5% are the most common. Another alloy that is usually considered is 99.7% tin, 0.3% copper; however this alloy is severely detrimental to soldering and rework tips. While silver containing solder alloys tend to be slightly more expensive, they are generally easier to work with and do not erode soldering tips as quickly.

Solder Types

Periodic Identification	Properties	Typical melting points
Sn Cu	Tin-Copper	227°c
Sn Ag	Tin-Silver	221°c
Sn Ag Cu	Tin-Silver-Copper	217°c
Sn Ag Bi	Tin-Silver-Bismuth	205°c to 215°c
Sn Zn	Tin-Zinc	199°c
Sn Pb	Tin-Lead	183°c
Sn In	TinIndium	118 °c

Silver is added to some lead-free solder pastes to assist with the wetting and joint formation during the rapid reflow phase of typical surface mount technology assembly processes. In rework situations it is important to always use the same lead-free alloy used in the original manufacturing process because when two different types of solder are mixed, unpredictable alloys can be formed, resulting

in questionable reliability of the solder joint. Lead contamination in a lead-free solder joint can significantly reduce the reliability of the joint.

A naturally occurring phenomenon in metals with high tin contents is “whiskering”. Microscopic whiskers can grow to several hundred microns in length. Tin whiskers are electrically conductive, single crystal, hair-like structures that can grow from lead-free solders with high tin content and will grow from pure tin surfaces. It is possible for tin whiskers to cause electrical short circuits in high-density PCB assemblies and with fine pitch components.

[PACE lead-free products](#)

PACE’s soldering systems offer legendary thermal control as well as advanced features to maintain your process. Unique PACE features such as Power Modules and/or password protection ensure consistency and quality in your process. Economical tips and standard features such as “Setback” and “Auto-Off” maximize tip life to reduce operating costs and increase your bottom line.

All PACE and SODR-TEK products are lead free-soldering compatible and can be used with any of the lead-free alloys without modification. Also, by July 2006, all PACE power supplies will be manufactured with lead-free PCB’s and materials.

PACE’s soldering systems and soldering irons are fully compatible with your lead free process. PACE’s TD-100 soldering iron boasts one of the most efficient heat transfer capabilities and is clearly one of the most responsive irons on the market today. This means that the TD-100’s ability to recover from thermal loading and maintain its heat output is far superior to other conventional irons, eliminating the need for higher, unsafe temperatures when using lead-free solders. Quick and consistent heat transfer also ensures that flux is fully activated and burned off leaving the work site properly prepared for the formation of highly reliable solder joints. Our PS-90 soldering iron has been the staple of the industry for years and is known for its amazing thermal capacity and ability to deliver the heat at safe, low temperatures. Both the TD-100 and PS-90 are available for use with nitrogen.

The MBT 350 rework station is a brand new, three-channel power supply that can utilize either the PS-90 (N) and/or the TD-100 (N) handpieces in the 8-pin configuration. PACE also offers a complete, self contained nitrogen based soldering system, the ST45N. The ST 45 N features the PS-90 N and is a fully programmable, digital, soldering station.

The benefits of nitrogen assisted soldering are available for almost all of PACE’s soldering stations with the N₂ Regulator Accessory which can be mounted to any PACE system that is made in an extruded case.

	TD-100 N, 4 Pin 6993-0273-P1 (kit) 6010-0155-P1 (handpiece only)	TD-100 N, 8 Pin 6993-0273-P1 (kit) 6010-0155-P1 (handpiece only)	PS-90 N, 4 Pin 6993-0275-P1 (kit) 6010-0116-P1 (handpiece only)	PS-90 N, 8 Pin 6993-0274-P1 (kit) 6010-0157-P1 (handpiece only)	N2 Regulator Accessory required (6993-0271-P1)
HW 50	↻				↻
TW 50	↻				↻
MBT 350		↻		↻	↻
ST 25			↻		↻
ST 45			↻		↻
ST 45N			↻		
ST 125			↻		↻
ST 145			↻		↻

PACE is also pleased to offer the NF 500 and NF 1000 nitrogen farms. Nitrogen farms harvest N₂ from a compressed air supply that is passed through a specialized filter. The other atoms that make up “air” are forced through the filter, leaving a pure stream of N₂ as the product of filtering. Nitrogen farms are passive collection devices which means that there are no electrical or moving parts, little or no maintenance, low running costs, and they maintain the balance of air/N₂ in a confined space (as long as the compressed air is pulled from the same space).

PACE also provides lead-free solder in convenient 4 and 8 ounce rolls under our Sodr-Tek brand.

Lead free soldering is inevitable and PACE is leading the way to meet the challenges our customers will face during the transition from lead containing to lead free soldering. PACE Incorporated is pleased to provide environmentally friendly, lead-free compatible tips. All of PACE’s soldering, desoldering and component removal tips are now tinned with lead free solder. Due to the corrosive nature of the high tin content in lead-free alloys and because more aggressive fluxes are commonly required when using lead-free solders, we have also optimized the iron plating on our tips to maximize thermal transfer while providing for the longest life possible.

Pace is leading the way in soldering technology. PACE's patented “DIAMOND SERIES” tips will be available in July 2006. The “**DIAMOND SERIES**” soldering tips are manufactured with an iron matrix that is impregnated with sub micron sized diamond particles. The diamond-impregnated surface is harder and corrosion resistant.

When reworking area array components with lead free solder, the greatest enhancement to existing equipment is the use of nitrogen for reflow. All of PACE’s Area Array equipment come fitted for nitrogen use as standard.

[Look for the PACE lead free symbol](#)

The PACE lead-free symbol is not only an aid in recognizing quality lead free products. It is a symbol of PACE's commitment to our customers and the environment. PACE Worldwide is systemically upgrading all of our manufacturing processes to meet the world's lead-free requirements. The presence of a Lead-Free logo indicates that a particular system is fully compliant with lead-free manufacturing requirements.



[PACE Worldwide Commitment](#)

With offices worldwide, PACE is a recognized world leader in the development of solution for the assembly and repair of highly advanced electronics. Our expertise extends back to dawn of the modern electronics industry. In 1958, PACE introduced training programs for the repair of printed wire assemblies, and soon after, revolutionized the industry by creating the first self-contained vacuum desoldering system.

Today PACE continues to provide innovative solutions, products and training for the rework, repair and testing of printed circuit assemblies. Our unique capabilities and evolving vision have provided universal solutions for thru-hole and surface mount assembly and rework problems for the most advanced electronics.

Additionally, PACE manufactures Fume Extraction Systems to reduce exposure to harmful particulates and gases created from hand soldering operations. PACE fume extraction Systems effectively remove these contaminants fro the workers breathing zone thereby reducing or eliminating health risks and improving productivity.

Our strong commitment and history of achievement has resulted in an unparalleled range of Assembly, Repair and Fume Extraction solutions to meet your needs whether working to ISO-9000, industrial, military or your own internal specifications. Whatever the challenge, PACE stands ready to help you set a new standard.