# Lead-free and RoHS implementation questions from the frontline, Part 4

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*July 1 has come and gone but the RoHS Directive hasn't gone away. In fact China is looking to implement its own version by March 1, 2007. This directive, the MII Methods Law still needs some clarification but will require testing of the product for banned substances, a test report and a label to accompany the product. This does seem to be much more demanding than its European equivalent.*

Kester has been very busy assisting assemblers with the lead-free transition throughout 2006. Conversion does seem to be in full swing for those that are not exempt. However, even companies that are exempt are looking or are implementing some lead-free lines. What are the motivators for exempt assemblers? They can be defined as follows:

- Leaded parts may be obsoleted
- Lead-free parts like BGAs seem to be more reliable with lead-free soldering
- Competitive or market pressures
- The global convergence of regulatory initiatives, China, Korea, Thailand, Canada
- Leaded solder exemption may be temporary
- If lead is permitted, the other 5 banned substances may not be

The above were well defined in a paper delivered recently in Toronto at the International Lead-free Conference put together by the University of Toronto CMAP. The paper by Dan Shea, Chief Technology Officer at Celestica, detailed the reasons why even exempt assemblers should be looking seriously at green manufacturing. His paper titled. "Guess What? There Are No RoHS Exemptions!" detailed the many challenges confronting assemblers that do not have to transition now.

We keep hearing that lead is a small fraction of the total used and many refer to leaded batteries as a main culprit for use. It is true that leaded batteries use lots of lead but the batteries have a recycling initiative in place and all lead is re-used, the plastic is used for its caloric content during the rotary furnace recycling process, the acid is recovered and the stainless steel nut under the polarity terminals also are used in the recycling process.

Nothing escapes to the environment, not quite so with electronics and electrical goods.

Like the previous publications this article is a compilation of some of the questions customers are asking. They are summary answers since each question could be answered in expanded form. If

additional information is required please do not hesitate to contact Kester for further assistance or do visit our website, www.kester.com where all previous articles are also available. All of them are still applicable as the majority of assemblers initiate the steps towards lead-free assembly.

**Here are some of the more often asked questions in the summer of 2006.**

**Where can I get more information on the Chinese RoHS equivalent directive?**

Information can be obtained at the following web address:

http://www.mii.gov.cn/art/2006/03/16/art_121_8441.html

A good paper on the topic is "Industry Challenges with China Environmental Product Regulations" presented by Matt Kelly of IBM Corporation, May 2006 at the CMAP Lead-free Conference. This paper is a good summary of the regulation as its stands today.

The broad strokes of this mandate are the creation of a catalogue of products that will need to abide with the regulation, labeling products that are compliant, having a test report on the banned substance content of the product, testing the product in a Chinese recognized laboratory, and using specific lead-free solders.

**Many assemblers are doing both leaded and lead-free soldering in the same location, what needs to be done to avoid cross-contamination?**

This question comes up more often during an audit where an assembler has just transitioned. Lead can create havoc in a lead-free wave operation. Lead-free bar comes in at lead levels < 0.05% while the RoHS limit is 0.1%. The unintentional addition of two 1 lb bars of Sn63Pb37 can elevate the Lead level beyond the RoHS limit. There is no practical way to remove lead in a wave pot so pot dumping or extensive dilution will be required.

Small amounts of lead under 2% do not seem to impact joint robustness however when soldering leaded parts within lead-free solders this is not exactly known, secondly if segregation issues are encountered due to insufficient temperatures during soldering than higher levels of lead may be present within certain parts of the joint. This could lead to reduced reliability. This applies to all soldering situations such as reflow, wave, hand-soldering and rework.

The first item in avoiding cross-contamination is a complete training of all operators. This includes those doing lead-free and leaded assembly. Identifying lead-free work zones by the use of large signage, green work station mats, identifying equipment with lead-free signs and insuring lead-free or RoHS parts and components are identified clearly, here some use green RoHS Compliant labels.

To summarize, the following could act as a good starting point to avoiding confusion.

- Identify the equipment with Lead-free and Lead-free symbols and signs
- Use LF bar solder that is triangular in shape instead of rectangular, usually Sn63Pb37
- Use soldering products with different packaging
- Different colors of dross bins for leaded and lead-free dross
- Train all procurement and process personnel about leaded and lead-free identification systems used by suppliers, example IPC-1066 or JES-D97

- Train all process personnel about the differentiating processes in place for lead-free and leaded, pre and post soldered assemblies
- Identify parts that are lead-free but not necessarily RoHS compliant or that are not lead-free process capable
- Use solder pot covers with triangular openings to avoid unintentional addition of leaded bars to a pot, where feasible
- Analyze solder pots regularly for main constituents but also lead and iron
- Use green "RoHS Compliant" labels on components and board packages
- Use green mats to identify lead-free work areas
- Identify soldering stations with a green stripe to differentiate them from leaded
- Identify stencils solely used for lead-free, especially if hand cleaned.
- Identify or segregate lead-free and leaded assemblies requiring further work or hand-soldering
- Separate, identify leaded and lead-free finished products

**If I am cleaning soldered assemblies can leaded and lead-free assemblies be cleaned in the same cleaning machine?**

The first thing to verify is if the present cleaning process and chemistries can in fact clean-off all lead-free residues. Lead-free flux residues will have seen higher temperatures. In reflow soldering, higher peak temperatures in the range of 240-255°C are typical. In wave soldering applications, longer contact times and higher pot temperatures are common. During hand soldering, higher contact temperatures may reach 800°F. This can result in some charring of residues or polymerization of the flux resins resulting in possible cleaning difficulties.

Asking the manufacturer if the flux residues can be easily cleaned after higher temperature processing is a good start. As an example, Kester works closely with the manufacturers of cleaning solutions to verify cross-compatibility. Materials that have been designed for lead-free operations will have been verified as lead-free process capable from a soldering and cleaning perspective.

If the flux is removable in your present process cleaning both leaded and lead-free soldered assemblies will be acceptable. Lead is very insoluble in water and most cleaning solvents, so it will not contaminate the lead-free products.

Checking ionic cleanliness is always a good idea, especially with the higher activity water washable fluxes. In lead-free soldering, higher temperatures can increase the risk of ionics remaining after the cleaning process. Checking ionic contamination levels after a flux chemistry switch is always a good practice.

**How about cleaning stencils contaminated with lead-free pastes or leaded?**

The same stencil cleaning solution will clean-off both leaded and lead-free solder paste residues. The resins and activators used in both lead-free and leaded pastes are usually from the same chemical family and the cleaning chemistries will very often remove the residues without change to cycle time and temperature.

Contamination of lead should not be an issue with stencil cleaning machines.

If stencils are cleaned by hand this can a demanding process and insuring all particles of leaded pastes are removed is critical. Examination of the apertures is important. As the powder diameter

decreases, cleaning becomes more difficult. It helps that often stencils destined for lead-free processes are not used in a leaded process.

**In reference to parts and components used in lead-free assembly, is RoHS compliancy sufficient information to receive from suppliers?**

In a recent lead-free wave build a connector exhibited minor plastic cracking after soldering. After examination, it was found that the connector was lead-free, but was not designed for the higher temperatures of lead-free wave soldering.

A part may have a lead-free finish on its terminations but not necessarily be able to take the added heat during lead-free reflow, hand soldering or wave soldering especially if long contact times are used.

Moisture sensitivity levels are also critical for hermetically sealed SMDs. The floor life of some components destined for lead-free reflow may be reduced. To avoid delamiantion, popcorning and die stresses during the soldering process, a bake-out procedure may be necessary. Understanding the MSL rating is important.

Other components may be tinned but not able to withstand higher temperatures without charring, discoloration or, in extreme cases, melting.

The other questions to ask besides lead-free and RoHS compliant are:

- Maximum processing temperature
- Type of termination finish and composition
- MSL rating for lead-free assembly
- The use of nickel under the tin to reduce tin whiskers

**What should I choose for a lead-free wave solder?**

Two popular choices exist, SAC305 and SnCu based solders. Another option is the low silver SAC also known as SACX. Presently 60% of assemblers have decided on SAC based solders and about 20% have selected SnCu based solders. The remainder is still undecided.

SAC305 has the advantage of having more data available about its reliability and processing. SnCu based solders have less data available at this time. However, both have their place in the lead-free wave solder world.

SAC305 contains 3% Silver and therefore costs more, elevating operating costs much higher than SnCu based solders. The wetting speeds during wetting balance tests indicated that SnCu-based solders were slower than SAC-based solders. This could translate into slower conveyor speeds and extended contact times in the use of these SAC alternates. This could be a bigger issue however with thicker boards in excess of 0.093" or difficult to solder boards such as OSP having seen a previous heating cycle.

Some of the characteristics of SAC305 in wave applications are summarized below:

- More information available
- High operational costs

- Patent-free
- Faster wetting than SnCu-based
- Grainy cosmetics
- Higher incidence of hot-tears on joint surfaces
- Higher oxidation than SnCu based solders with dross-reducers
- Higher dissolution of copper
- Higher dissolution of iron based solder pots

Some of the characteristics of SnCu based solders (such as K100LD) are as follows:

- Lower costs
- Less dross
- Less surface shrinkage effects
- Bright solder joints
- Less dissolution of copper
- Less leaching of iron in solder pots
- Reduced maintenance costs

It is important to note that the above information compares SAC305 to Kester's K100LD solder bar. This patent-pending alloy out-performs all other lead-free solders in reference to the rate of Copper dissolution. It is a SnCu based solder with special additives to enable excellent wetting, reduced dross and extremely low Copper dissolution.

**What should I choose as a lead-free tinning solder?**

Solder tinning can also accommodate both SAC305 and SnCu based solders. The key to is to give a good solderable surface and both SAC305 and SnCu based solders are lead-free and easily solderable surfaces.

SnCu based is the lowest cost option and can produce a bright finish if the alloy contains a nickel dopant.

The slightly higher dip tinning temperatures used in this process do not impact wetting speeds. However, choosing SnCu based solders with certain additives can reduce dissolution of base metals reducing termination leaching and solder pot maintenance.

In the tinning of particularly thin diameter terminations the lower dissolution of K100LD can be a potential advantage and increase the reliability of the tinning.

As the year progresses more questions will definitely arise. Stay tuned for more answers to assist those at the frontier of lead-free assembly.

***About the author:***
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*He has been involved in numerous consortia within this time and has assisted many companies implement lead-free successfully. He is an active member of IPC, SMTA, and ASM. He is the author of many technical papers delivered globally. He is also a Certified SMT Process Engineer.*

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