The Folly of RoHS

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The folly of RoHS is clear: **RoHS may create massive environmental problems in attempting to solve a non-problem with lead solder in electronic equipment.**

RoHS ("Reduction of Hazardous Substances") is a directive issued by the European Union (EU) to eliminate potentially hazardous materials, including lead, from electronic equipment. A major objective is to protect people against the health problems that could be caused if lead solder in discarded electronic equipment leaches into drinking water.

The directive might as well have also included protecting us from the hazards of dragon bites, unicorn stampedes, and pieces of the falling sky. **No studies have established that any such lead-related problem exists. Studies suggesting that the problem does not exist have been denied consideration.** [1]

Unfortunately, the directive neither resulted from sound scientific studies, nor took into account that strengthened recycling regulations will adequately protect us from discarded electronic equipment's assumed hazards. Worse, **the directive did not first consider the major environmental and health consequences of lead-free solder alternatives.**

The RoHS directive was issued in January 2003. Comprehensive environmental impact studies of lead-free solders were not completed until 2005. The EU's report on implementation, released 28 July 2006, states that **RoHS was a political decision, and therefore is not appropriate for their scientific review.** [1]

The principal solders now being introduced to solve this non-problem are predicted in several models to have larger negative effects on environmental pollution, fossil fuel consumption, cancer risk, and global warming than tin-lead solder.

A 472-page study issued by the U.S. Environmental Protection Agency in August, 2005 gives a life-cycle assessment of the environmental impact of four proposed lead-free solders, compared to tin-lead solder. [2] A life-cycle impact calculates the environmental consequences of a product system over its entire life, from the production of the raw materials to the end-of-life disposition of the product.

As shown in Table 1, in this assessment the most popular lead-free solder, **Tin-Silver-Copper (SAC) has a higher environmental impact than tin-lead in 10 of the 16 categories, including Energy Use, Global Warming, Ozone Depletion, and Public Human Health – Cancer**.

Impact Category	SnPb	SAC	Exponent
Non-renewable resource use	1.61	1.82	E +03
Energy use	1.25	1.36	E +04

Landfill space use	2.75	16.2	E -03
Global Warming	8.17	8.73	E +02
Stratospheric ozone depletion	9.95	11.0	E -05
Photochemical smog	3.13	6.18	E -01
Acidification	6.50	12.5	E +00
Air particulates	4.52	13.0	E -01
Water quality	1.79	2.26	E -01
Public human health – cancer	6.96	7.05	E +00

TABLE 1. Environmental impact, leaded versus lead-free solder paste.
Source: U.S. Department of Environmental Protection [2]

The University of Stuttgart, Department of Life Cycle Engineering, performed a life-cycle hazard study of lead-free solders covering five potential impact categories: global warming, acidification, photochemical oxidants, ozone depletion, and human toxicity.[3]

Ten possible lead-free solder replacements were compared with standard eutectic tin-lead solder. In this comparison, **today's tin-lead solder shows the lowest or near-lowest adverse impact in every category.** For example, Figure 1 shows the comparison for Human Toxicity Potential. Tin-Lead is at the left; Tin-Silver-Copper (SAC) is second from the right.

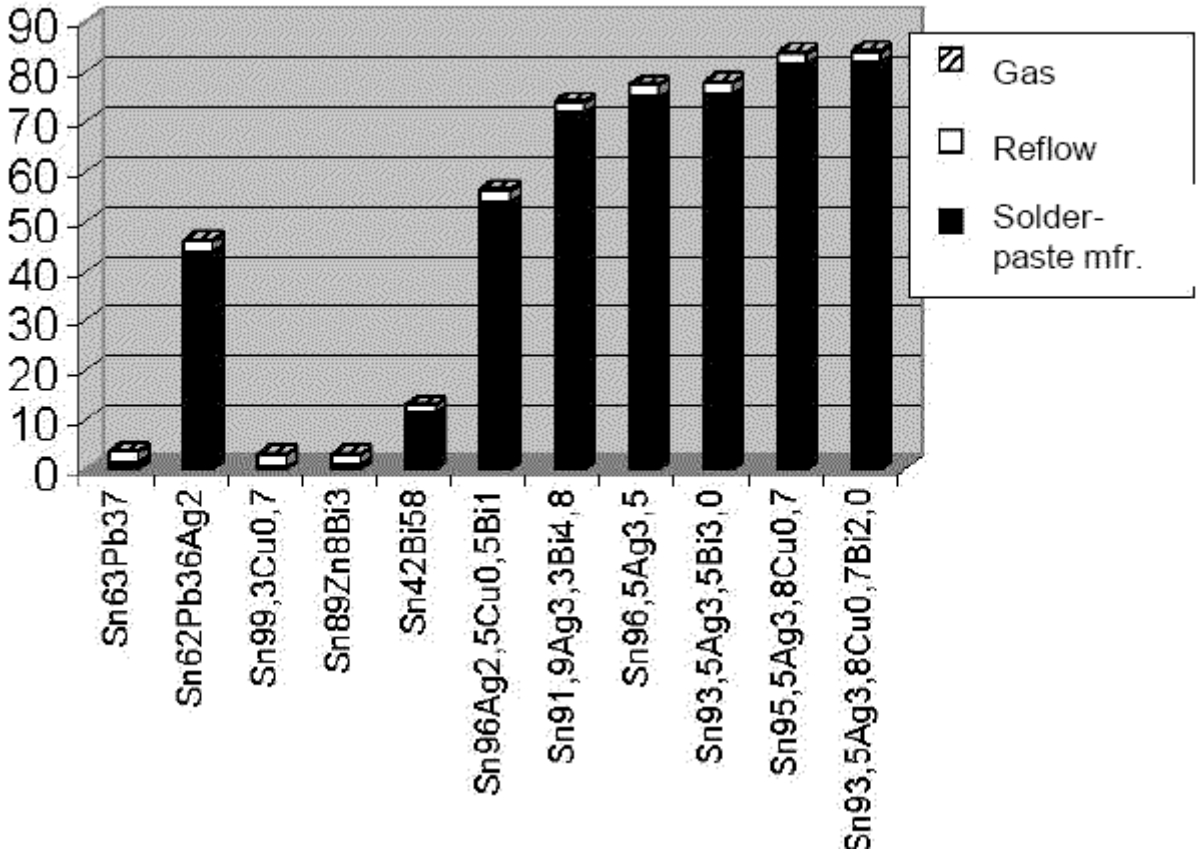

FIG. 1 Human toxicity potential, life-cycle comparison. Tin-lead solder paste is left-hand column. Tin-silver-copper (SAC) is second from right.
Source: University of Stuttgart, Department of Life Cycle Engineering (Ref. 3)

In addition to the potential environmental hazards discuss above, lead-free solder substitutes raise concerns about reliability, cost, and misapplied technical resources.

RELIABILITY

The long-term reliability of some of the proposed lead-free solders is still being debated. Reliability is too broad a subject to detail here, but numerous technical papers and articles have addressed the topic over the past few years. Whether "tin whiskers" or "tin pest" are real problems, or only theoretical ones like lead landfill leaching, remains to be seen. Unfortunately, none of the lead solder substitutes have a reliability data base approaching the 2,000-year history of tin-lead solder.

In a disturbing indicator of serious reliability concerns, **the United States government will not allow lead-free solders to be used in military or aerospace (high-reliability) electronic equipment** until the reliability of the new formulations is firmly established. Consumer and commercial users will be the lead-free solder reliability guinea pigs.

COST

While lead-free reliability is merely questionable, lead-free solder overall costs will unquestionably be higher than for tin-lead solder. **Hundreds of millions of dollars have already been spent** in the conversion process, on training courses, process development, qualification testing, and new equipment.

On-going operating costs for more expensive and scarcer materials, higher use of thermal energy, longer and less forgiving (lower yield) **production processes over time will add billions of dollars to electronics equipment costs**, dwarfing the conversion outlays. Higher costs and lower profits ultimately get passed along to customers as price increases.

MISAPPLIED RESOURCES

The invisible and non-recoverable cost of lead-free is what economists call an "opportunity cost." The **opportunity cost of lead-free solder is the hundreds of thousands of hours of skilled technical labor consumed** in the lead-free preparation and conversion. The advances in electronics, in manufacturing, in new products, in enhanced capability and lower costs that these trained technical personnel might have achieved on other programs have instead been forfeited for a delusion.

WHAT'S THE SOLUTION?

In a recent Electronic Business article, Joseph Fjelstad, CEO and founder of Silicon Pipe, concisely listed **12 facts supporting his call for the repeal of RoHS**. [4] While repeal

is the best solution, recent history reminds us that politicians seldom admit major mistakes.

Let me suggest perhaps a more politically palatable solution. Indicative of the flaws in RoHS are the many exceptions, granted or pending, where the new rule has already been found wanting. Currently 28 exceptions have been granted; some 70 more exceptions are pending.

An exception must meet only three criteria: impractical to remove through design change; unavailable commercial-quantity substitutes; negative environmental, health, or consumer safety impact of substitutes.

It is clearly impractical to remove all soldered connections from electronics. Per the studies cited above, all of the proposed lead-free solders increase environmental hazards over present lead solder. Therefore, feasible lead substitutes do not exist in commercial quantities. **Thus, by the EU's own rules, all current uses of leaded solders in electronics meet their requirements for and are entitled to receive exemptions.**

A blanket exemption offers the politicians European Union a face-saving retreat from their blunder. It allows our industry to stop our current regression in solder technology, and to resume our progress in electronics. We are in only Act One of this tragedy. **There is still time to stop the show.**

NOTES

[1] "Adaptation to scientific and technical progress under Directive 2002/95/EC," a report by Öko-Institut e.V. and Fraunhofer Institute for Reliability and Microintegration IZM, prepared for the European Commission. Report Sections 5.2.1 and 5.2.2 specifically decline consideration of the EPA environmental hazard report and of a report challenging the alleged ground water pollution by lead solder.

[2] "Solders in Electronics: A Life-Cycle Assessment Summary." United States Environmental Protection Agency Publication EPA-744-S-001, August 2005. Data excerpted from Table 4.1.

[3] Excerpted from p. 23 of the presentation by Niels Warburg, University of Stuttgart, at IPC APEX 2003. Available at http:leadfree.ipc.org/files/RoHS_15.pdf

[4] Joseph Fjelstad, "Note to European Union – Repeal RoHS!" Electronic Business 7/25/2006. http://www.reed-electronics.com/eb-mag/article/CA6355639

ACKNOWLEDGEMENT

While I have been concerned for some time by the waste, folly, and technical regression of RoHS, Joe Fjelstad's excellent article, and an exchange of emails with him, stimulated me to break my unaccustomed silence and likewise speak out to share my concerns.