e Book

electronic
design

Guide To New International Environmental Laws

By Ron Schneiderman

RoHS

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If you don't know what RoHS means, you're probably in trouble—or you soon will be. The 25 countries composing the European Union (EU), as well as China, Japan, Korea, the U.S., and pretty much the rest of the world, are about to restrict the use of environmentally hazardous substances in electronic products. But currently, the EU is pushing most of the buttons. Most of the industry has to get on board soon or stand to face penalties and lost business.

Under the EU's Directive 2002/95/EC, better known as Restrictions on Hazardous Substances (RoHS), hundreds of thousands of products currently produced and marketed by industry companies could become obsolete, forcing semiconductor and other electronics manufacturers to determine what products they have to redesign to remove toxic materials. The EU's RoHS legislation calls for the removal of lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, and polybrominated diphenyl ethers. Each of these substances must be reduced below the concentration values set by the EU.

Lead is considered the biggest offender and will have the largest impact on most industry companies, especially consumer electronic OEMs and semiconductor manufacturers. But other materials, such as hexavalent chromium, present a particular problem for design engineers because there's no substitute material available of equal performance.

E-waste is emerging as a global problem, and it is growing faster than the industry can control. The National Safety Council estimates that 254 million home computers became obsolete in the U.S. between 1997 and 2003. Another 250 million are expected to become obsolete between 2004 and 2007 *(Fig. 1-1)*. The Gartner Group, a market research company, expects Americans to replace or junk 133,000 PCs per day this year alone.

What about cell phones, digital cameras, and the millions of other mostly
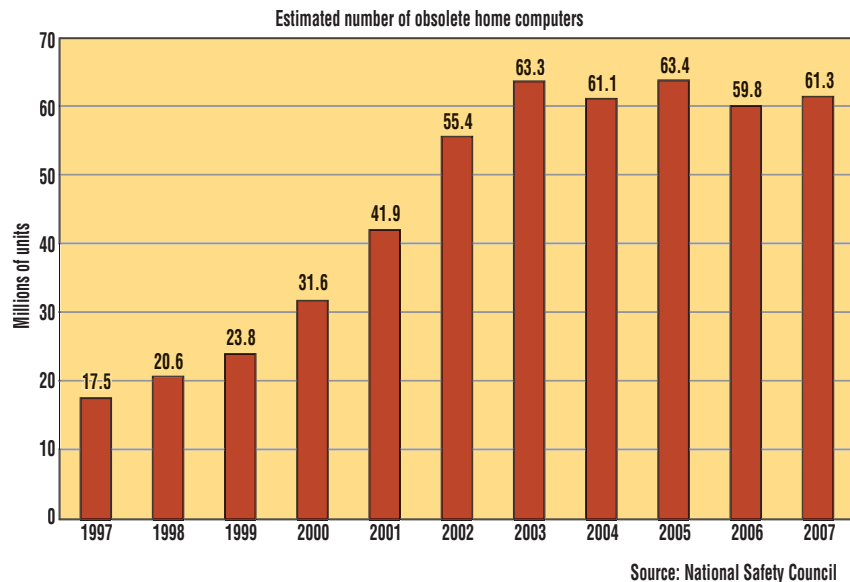
1-1. The National Safety Council projects that 250 million PCs will become obsolete between 2004 and 2007.

consumer electronic toxic-laden products? According to Dana Joel Gattuso, a policy analyst for Washington, D.C.-based Competitive Enterprise Institute and the former director of projects and issues management at the U.S. Chamber of Commerce, toxic materials contained in computers and other electronic products are leaking out to landfills and poisoning ground soil and groundwater.

A companion directive to the RoHS, Waste Electrical and Electronic Equipment (WEEE) requires companies that sell electronic products in Europe to set up collection and recycling systems for discarded goods. Compliance with the RoHS and WEEE is expected to cost the industry about $40 billion just to get geared up for the new rules, mostly for redesign and retooling. The cost to each company is estimated to range from 3% to at least 10% of their revenue. "This may take some time to sort out," says one industry source.

NOT MUCH TIME • The electronics industry must fully comply with the RoHS directive by July 1, 2006. Despite past extensions of the deadline, the EU's Technical Adaptation Committee (TAC), with members from each EU state, has advised the industry to take the 7/1/06 deadline seriously. There will be no grace period. This means companies that aren't in compliance with the RoHS directive by the deadline will not be able to sell their products into EU countries.

Most of the industry, particularly OEMs but also chip designers and manufacturers, electronic manufacturing service (EMS) providers, distributors, and other hardware suppliers, are already well along in preparation for meeting the RoHS deadline. But many companies are only now beginning to prepare for its requirements. In fact, several still haven't gotten the message and are in real danger of missing the boat.

Some language of the RoHS has not been ratified, complicating the entire process. This language includes the definition of materials and the establishment of the maximum concentration values (MCVs). In March, the European Commission (EC) said it would resubmit an MCV draft proposal to its Environmental Council and that it expected the process of re-evaluating this information to take at least into late July.

"This is another challenge for the supply chain," says Leone Tipton, vice president of Supply Chain Programs at Arrow Electronics. "We know from talking to our customers and from the many seminars we have held that there are still a lot of companies trying to work out what all this means to them, particularly given the ambiguity of the legislation, and the exemptions."

With all EU countries having not yet adopted formal RoHS legislation, as required, the U.K.'s Department of Trade and Interior (DTI) has recommended self-certification, which means that suppliers and manufacturers would certify their products as RoHS-compliant. Many companies with the resources to stay on top of RoHS and WEEE developments are helping their customers and suppliers with everything they'll need to meet the requirements in the RoHS directive, from design to testing to turnkey compliance and database development. "We're encouraging customers to really put their planning in place now," says Tipton.

It hasn't been easy. "We're having an extremely difficult time convincing our customers they should be focusing on this," says Steve Schmidt, president and CEO of APSCO, an Ohio-based EMS provider. According to Schmidt, most U.S. EMS providers with revenue under $100 million are still way behind the curve in preparing for RoHS. But he says that many of these companies say they're not concerned because they don't do any business in Europe.

Exemptions have become one of the more controversial and confusing aspects of the RoHS. Military applications, along with some medical devices and certain types of telecommunications networking and infrastructure equipment, are already exempt. But companies have been applying to the TAC for their own exemptions.

To lighten the load, the TAC is trying to tighten the parameters from which it will consider these requests. The technical committee also is asking for more due diligence from OEMs to prove that it's impossible for them to comply without an exemption.

Part of the problem, according to Dennis Pohl, a product policy expert with the Belgian Federal Environmental Protection Agency and a member of the TAC, is that the committee still hasn't completely worked out what it would take—that is, what reasons—would qualify for exemptions. As a result, few of these companies are likely to have their exemption requests approved, or approved by the July 1, 2006 deadline. In addition, the EC will not fund independent research studies that would help support an exemption request. Any study must be funded by the company proposing it.

You can also forget about using noncompliant components for spares and repair functions indefinitely. The RoHS directive says that noncompliant spares can only be used in products "put on the market" prior to July 1, 2006. Products "put on the market" after the deadline must be repaired using complaint products. The TAC has defined "put on the market" to mean "placing on the market is the initial action of making a product available for the first time in the EC market, with a view to distribution or use in the EC."

Another hot button is the definition of homogenous materials. Michelle Raymond of Raymond Communications, which tracks environmental e-waste laws and issues, says this is critical to circuit-board designers who need to know the MCVs of the restricted substances in pc-board assemblies, and in components on a board and the materials, as well as coatings. Initially, the thinking was that the term applied to component or pc-board-level electronics. The latest interpretation of "homogeneous" developed by the EC and approved by TAC characterizes it as "of uniform composition throughout."

Packaging is another issue that continues to confuse component manufacturers. While the RoHS affects the components themselves and their material content, chips come in different packaging, like trays, cardboard boxes, and other forms. Even though these are not covered in the RoHS directive, some manufacturers are requiring material declarations on packaging from their suppliers.

A more recent, and potentially problematic, EC initiative is the Design Directive, which deals with eco-design. This means integrating environmental considerations at the design phase of a product. The EC calls this "arguably the best way to improve the environmental performance of products." At one point, this proposal was part of both the RoHS and WEEE directives, but it eventually got separated. The present proposal, according to Raymond Communications, aims to create a comprehensive and coherent legislative framework for addressing eco-design requirements. At this time, however, the design directive proposal stands in limbo because the EU has rejected amendments that would have clarified its intent and language. But it is still under discussion.

THE INDUSTRY RESPONSE • Most industry companies, particularly the larger chip and test equipment manufacturers and OEMs, have been working on RoHS issues for at least two years, some even longer. To ensure that they're protected from any penalties or other unpleasant surprises, OEMs are asking their suppliers to sign off on formal documents or declarations—usually of their own design—to ensure that they will be in compliance well before the RoHS deadline. Some component manufacturers are even visiting customers to determine their state or level of compliance. "Samsung Wireless visited in February to check on us," says Paul Chantalat, vice president of quality and reliability at Linear Technology.

In addition, several OEMs have also sent lengthy questionnaires to their suppliers. Some of these cover ground not even mentioned in the RoHS or WEE directives.

"The RoHS covers six materials, but some of the questionnaires cover as many as 30 chemicals," says Phil de Guzman, manager of quality assurance for memory products at Toshiba America Electronic Components. "Customers are anticipating that additional substances will be banned in the near future—maybe in a year to three years, and possibly by countries other than EU states—and they're proactively asking about these chemicals now."

How can industry manufacturers ensure that their products meet the RoHS compliance deadline? A new specification adopted by IECQ, known as the Quality Assessment System for Electronic Components, specifies the technical requirements that manufacturers must meet to ensure that

their products conform to the new lead-free requirements. IECQ is a global business-to-business quality certification service for the electronics industry. The International Electrotechnical Commission (IEC) also has formed a technical committee, TC111, that is developing procedures for determining levels of regulated substances in electronic products.

DIFFERENT SOLUTIONS • Each company has come up with its own solution to getting the lead out of its products, with reams of data supporting the individual choice as the best alternative *(Fig. 1-2)*. The issue of making products lead-free, at least as Milpitas, Calif.-based Linear Technology sees it, is basically this: Current lead-free solder paste alternatives, which have a 25°C to 50°C higher melting temperature than tin-lead solder, push the performance limit of the systems used in pc-board assembly. In addition, the 260°C peak reflow temperature used on lead-free alternatives will adversely affect the moisture per-

Standard soldering profile

1-2. The standard soldering profile looks like this, although some companies also have tested packages in lead-free finish versions. These products have no external lead, but they contain internal lead in the form of die/lead bonding solder. Remaining lead percentage by weight will vary according to product package and type.

formance of the company's packages. To date, moisture sensitivity testing conducted at a peak reflow temperature of 260°C has confirmed this drop in moisture performance. But results to date indicate that Linear Technology's matte-tin packages are still reliable after exposure to these more stringent reflow conditions.
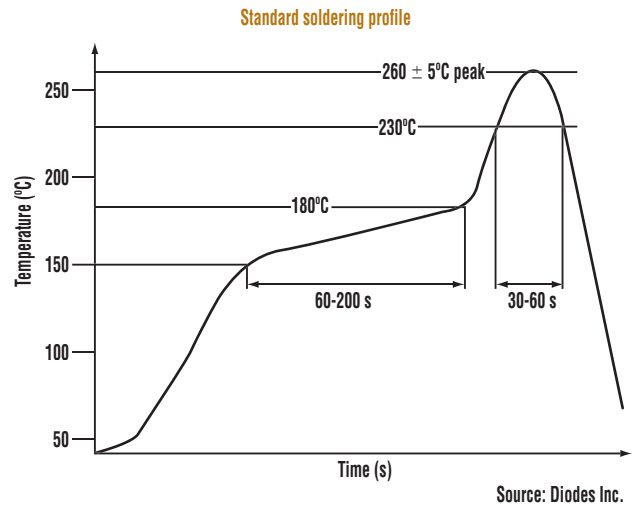
Toshiba is using a variety of lead-free alternatives depending on the product, country of manufacture, cost, materials availability, and thermal environment of the product. Six primary alternatives selected by Toshiba for its portfolio of more than 35,000 electronic components include tin silver (SnAG), tin silver copper (SnAgCu), nickel palladium gold (NiPdAu), gold (Au), silver (Ag), and tin copper (SnCu). Most others offer fewer, but well documented, choices.

Will leaded and lead-free components perform any differently? Most chip manufacturers insist that eliminating lead will not create any performance issues and claim that they have the reliability test data to prove it. Others disagree and anticipate reliability problems. (Technical approaches by other companies will be addressed in detail in a future chapter.)

Organizations like the Computer-Aided Life Cycle Engineering (CALCE) Electronic Products & Systems Center at the University of Maryland have organized a Lead-Free Forum to bring together academia and industry to address issues that include lead-free solder alloy selection, characterization of lead-free solder alloy properties and behavior under various stress loading conditions, lead-free manufacturing, logistics and intellectual-property issues, and lead-free assembly reliability assessment.

FOCUS ON OEMs • Even though just about everyone has to get with the program, OEMs bear the final responsibility for compliance. Most OEMs are on board at this point, at least to the extent that they're aware of the RoHS and WEEE requirements and are making a serious effort to comply. But there is still a lot of confusion about how to interpret the language of the RoHS. OEMs, more than others, are also asking most of the questions at seminars. For example, what does proof of compliance mean? And what exemptions does their company need, if any?

The move to eliminate toxic materials from electronic products has become a global effort. Chi-

na's Ministry of Information Industry (MII) has been working on lead-free legislation, and its Article 11 requires manufacturers to restrict the use of the same substances targeted by Europe in certain consumer electronic products. Expect China's Regulation for Pollution Control of Electronic Products (RPCEP) by the end of June.

Japan has been on top of the environmental issue for years, and its Electrical Appliance and Material Safety Law governs the use and control of hazardous substances in products sold in the marketplace. Japan believes its environmental laws already comply with global directives, including the RoHS and WEEE, and isn't expected to introduce any additional legislation. (In fact, Japanese manufacturers, particularly in the consumer electronics sector, started to place lead-free restrictions on its suppliers a few years ago.)

South Korea and Taiwan are also working on RoHS-type legislation, and Mexico has proposed legislation with provisions similar to the RoHS.

The U.S. has no national legislation covering the disposal of electronic products or restrictions of toxic materials used in electronics, but regulations similar to the EU's RoHS and WEEE are being proposed and adopted in several states. There are 23 new electronic waste bills in state hoppers in 16 states. California and Massachusetts have already enacted laws to restrict the use of hazardous substances.

FUTURE CHAPTERS • We will get into more detail on the issues discussed here in future chapters. These include China's and Japan's position on removing toxic materials from their (and your) products, compliance and transition issues, how the industry is responding to these new and challenging rules, the U.S. response, and the outlook for future environmental proposals and policies the industry is likely to face going forward. Also, look for a list on *Electronic Design*'s Web site of industry, government, trade association, product obsolescence specialists, and independent contacts of interest.

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Chapter 2: China & Japan Develop Their Own Hazardous Substances Programs

by Ron Schneiderman

China already has indicated that its new hazardous materials rules will closely resemble the European Union's (EU's) Restrictions on Hazardous Substances (RoHS) directive. Companies exporting to China will be affected by virtually the same RoHS-type regulations as when they do business in Europe. China also is expected to adopt the EU's deadline for RoHS compliance of July 1, 2006.

Japan, on the other hand, has taken a different approach in cleaning up and recycling hazardous materials in electronic products, but it also will comply with the RoHS. In fact, Japanese OEMs have been making fairly strenuous environmental demands on its suppliers for years, both domestically and globally.

China's electronics industry has a lot at stake. Electronics accounted for about 70% of the country's exports to the EU, worth more than $100 million, according to the China Electronics Import & Export Corp. But China's exports of electronics could fall by 30% or more, some analysts believe, because many companies in China aren't expected to meet the EU's new RoHS requirements.

China's concern with meeting new and emerging environmental regulations aren't only in response to the EU's actions, but also Japan, where it supplies many manufacturers. According to Steve Hopkins, vice president of RoHS business development at Newark InOne, a distributor of small quantity components and test equipment, unlike the EU, China doesn't plan to allow any of the exemptions that are helping to soften the regulation's impact in Europe.

China's Ministry of Information Industry (MII) expects to publish its RoHS-like regulations by the end of 2005. At least six Chinese ministries have contributed to writing the Management Regulation on the Recycling and Treatment of Disposed Appliances and Electronics Products regulation, including the State Environment Protection Administration (SEPA).

Significantly, the Chinese directive will cover all electrical and electronic products produced in, or imported to, China. Noncompliance could mean heavy fines and/or losing the right to do business in China.

China also vows to comply with the EU's Waste Electrical and Electronics Equipment (WEEE) directive. Under this directive, companies selling electronic products in Europe must collect and recycle all discarded electronics. WEEE applies to all electronic products, including future and "historic" e-waste. China's National Development and Reform Commission is responsible for drafting regulations that fall into line with the WEEE directive. SEPA is expected to enforce WEEE regulations scheduled to begin in August.

"We are pretty sure the Chinese agency officials involved are sensitive to the importance of harmonizing their approach with the European WEEE and restriction on the use of certain hazardous substances directives," notes Richard Ferris, China legal expert and a partner at the international law firm of Holland & Knight LLP. However, Ferris says that aspects of the proposed Chinese laws addressing RoHS and WEEE will be uniquely Chinese. In the RoHS case, these fall into the marketing and labeling category. Ferris also says it's not clear if China will apply to the EU for exemptions and, if so, what market sectors or products they would focus on. Additionally, he anticipates a

shakeout of some smaller- and medium-size Chinese companies due to the difficulty in meeting the EU's environmental directives.

TAKING BACK RECYCLED PRODUCTS

Most Asian countries are well ahead of the U.S. and Europe in handling e-waste and what the recycling industry refers to as end-of-life electronics products. "The major Asian countries have had electronics takeback laws on the books for a number of years," says Raymond Communications, a consultant and publisher of environmental reports. "While China seems to be the first to adopt the European-style RoHS on a mandatory level, we are now seeing a number of other Asian countries move in the direction of requiring similar RoHS standards."

Chinese companies are getting governmental help, mostly from the MII's science and technology group and SEPA, in researching alternative materials to meet the EU's new RoHS technical standards. In a document called "Management Methods for the Prevention and Control of Pollutions from Production of Electronic Information Products," China's MII says it may provide production and development funding to organizations that actively research and develop new environmentally friendly electronic information products.

The draft also says that the MII and administrative departments of quality and technology supervision, inspection, and quarantine shall uniformly implement specific testing standards for products listed on the catalog of national key electronic information products. And while China's hazardous materials legislation is expected to be "very similar" to the EU's, Jianzhong Huang of the Chinese MII told a conference sponsored by Soldertec Global, a membership-based organization focused on research in soldering technology, including lead-free issues, that the Chinese RoHS law may have a few wrinkles of its own based on recommendations by the World Trade Organization (WTO).

"All regulations have to be examined by the WTO in order to assess effects on trade. This is common practice," says Kay Nimmo, research director at Soldertec Global. The WTO has more than 120 members, more than two-thirds of which are developing countries and over half of which are formally associated in some way with the European Commission. The WTO's Trade & Environment Committee reports directly to the organization's General Council, which also functions as the WTO's Trade Policy Review Body. According to Nimmo, the WTO evaluates and comments on all new laws, including those from the EU and China. (China formally joined the WTO in December 2001.)

U.S. ASSISTANCE

Meanwhile, several American companies are assisting their Chinese and other Asian customers in complying with the RoHS directive. Arrow Electronics already has a running start in assisting customers in the region with system designs and technical support that extends its ability to support customers in China's fast-growing electronics market. Arrow Asia Pac Ltd., a subsidiary of Arrow Electronics, recently signed a franchise agreement with Linear Technology that makes Arrow Asia Pac a distributor of Linear's full range of products through its 18 sales offices in mainland China and Hong Kong. (China accounts for an estimated 15% of the global semiconductor market, which is projected to grow at an annual rate of more than 20% through 2008. Several American and European electronics companies have already made major investments in manufacturing and R&D and design centers in China. Additional U.S. investment is expected.)

THE JAPAN FACTOR

Japan is well ahead of the global curve in protecting the environment and recycling e-waste. In fact, most of Japan's consumer electronics OEMs have been specifying lead-free materials and the removal of other toxic substances from their suppliers' components for several years.

"Several Japanese manufacturers, including Toshiba, proactively began eliminating heavy metals and other potentially hazardous substances from their manufacturing processes several years ago," says Stephen Marlow, executive vice president of Toshiba America Components Inc.

Toshiba America Electronic Components also demonstrated in May an extensive array of advanced displays and display technologies developed by Toshiba Matsushita Display Technology

Co. Toshiba is targeting cell phones, mobile computing, and automotive and industrial applications with these display technologies. The company also stresses that all of the new high-brightness displays for industrial applications meet RoHS requirements.

Max Elbaz, general manager of Underwriters Laboratories' Restricted Substances Compliance Solutions (RSCS) Program, says that in most cases, Japanese companies have self-declared their compliance with Japanese environmental laws.

Japan already has several environmental laws in place, including the Promotion of Utilization of Recycled Resources, which regulates computers and other electronic products and rechargeable battery recycling. Most Japanese companies expect to be RoHS-compliant by March 1, 2006, four months before the EU-imposed deadline.

But the laws aren't exactly in tune with what the EU is proposing. Kanji Tamamushi, founder of Tamamushi Environmental Consulting Inc. (TECI), a consultancy specializing in U.S. and Japanese environmental packaging and product stewardship requirements, says that the laws don't cover all electrical equipment. Also, risk-management factors and concepts aren't an issue in Japanese environmental laws. "Japanese industry will comply with RoHS," says Tamamushi, "and will request their suppliers to collaborate and comply with it." Sooner or later, Tamamushi says, the EU's RoHS requirements will become de facto laws in Japan.

Will Japan penalize foreign companies that don't comply with any of its environmental laws? It will, says Tamamushi, as soon as it identifies them.
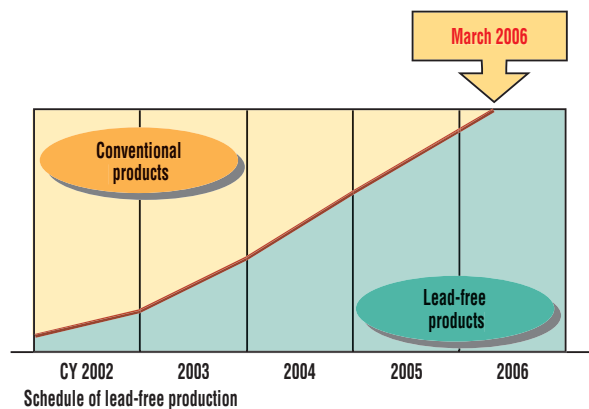
Japan also has developed its 3R Policies (reduce, reuse, recycle), which call on the industry to voluntarily recycle its products and materials. As part of the 3R Policies program, Japan has released a set of guidelines on recycling for items and industries not subject to certain laws and regulations. Japan's Ministry of Economy, Trade and Industry (METI) also is considering establishing targets under the 3Rs at the product design and manufacturing stages. If required, it will take measures to add these targets to the METI Recycling Guidelines or upgrade them into laws to further promote recycling. "We will continue to examine options, taking into consideration trends relating to the European Union's RoHS Directive," says a document published by METI.

Japanese electronics manufacturers began removing lead from their processes in 1998 when the Japanese government increased fees for recycling leaded equipment. Since then, says Steve Hopkins of Newark InOne, the Japan Electronic Industry and Technology Association (JEITA) has been considering removing several other substances from its products, including tin, zinc, and bismuth alloy solders. Japan also has developed a list of 29 restricted substances it may eventually want removed from its OEMs products, but it does not yet require its suppliers to test for the presence of these materials.

Japanese OEMs are sending questionnaires to their suppliers as well. "Our first BOM conversion was from a customer in Japan, and it covered 40 different chemicals," says Art Morgan, director of technical marketing at Solectron, a contract manufacturer.

Virtually all of Japan's larger electronics companies have established chemical project teams or departments to ensure their compliance with the RoHS and have developed chemical substance control manuals for the RoHS and WEEE directives. They also have been increasing their screening and analytical capabilities and have implemented chemical substance control systems.

For example, Sony launched its Green Partner supply-chain management program in July 2001. As Sony executives explained at the May 2005 IEEE International Symposium on Electronics & the Environment held in New Orleans, the company uses the program as a tool to prequalify vendors. It's also now used to

March 2006

Conventional products

Lead-free products

CY 2002   2003   2004   2005   2006
Schedule of lead-free production

2-1. NEC Electronics is well on its way toward switching over to lead-free products and expects to completely eliminate lead from its components by the end of March 2006. Source: NEC Electronics

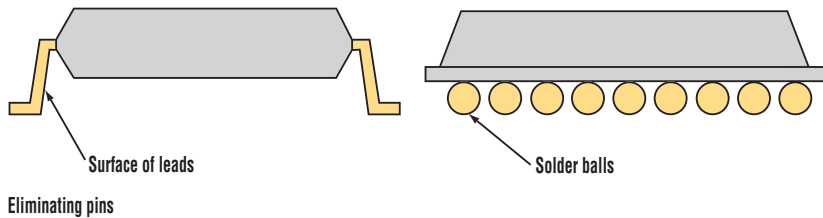enable certification of RoHS-compliant products for the future.

Sony says it didn't start the program in anticipation of the RoHS, but in response to spot checking its products in the Netherlands. That's where Sony found that flexible cords purchased from a supplier for its game console had cadmium contamination, resulting in shipment suspension of the unit for several weeks. As Sony pointed out at the New Orleans meeting, this incident opened the eyes of management to the magnitude of the issue. (In one of its corporate social responsiblity reports, regularly updated by Sony, the company says it used approximately 154 tons of lead solder in Fiscal 2003, adding that it plans to phase out the material in its products this fiscal year.)

TDK Corp. also recently announced that it has removed substances from its general-purpose components, including capacitors, inductors, filters, and other products, as required for RoHS compliance. In addition, the company has stopped using polyvinyl chloride in its general-purpose components and packing materials.

NEC Electronics says it expects to be lead-free by the end of March 2006. It is focusing on eliminating lead from the constructional elements of all of its semiconductor products, beginning with lead-free pin components *(see Figures 2-1 and 2-2)*.

Hitachi's Integrated Management System for Chemical Substances Contained in Products is designed for the storage, central management, and quick retrieval of information on manufacturing and shipping records, component materials, existence and amount of controlled chemical substances, and the quality record during the product's manufacturing.

Surface of leads

Solder balls

Eliminating pins

2-2. NEC Electronics is focusing on eliminating lead from the constructional elements of all of its semiconductor products, beginning with lead-free pin components. Source: NEC Electronics

The company has developed a system to trace and control chemical substances in purchased and shipped products. However, it doesn't expect all of its internal environmental programs to be fully operational until June 2006.

OTHER AREAS OF INTEREST

South Korea's environmental laws, implemented in 2003, rely more on consumers to maintain a healthy environment. Under the county's "takeback" laws, consumers can return old consumer electronic products and appliances free of charge to the supplier when they purchase a new product. If consumers don't buy a new product, they can purchase a sticker and the government will take care of the collection and recovery. Certain products, such as TVs, require extra fees.

South Korea's Samsung Electronics has developed an Eco-Partnership program as part of the Green Procurement System it created in 2001 to comply with environmental regulations, promote products with environmental quality, and produce more environmentally certifiable products. New Jersey-based Anadigics recently achieved certification under the program by successfully completing Samsung's Green Procurement Audit, which covers environmental management systems, manufacturing processes, and product composition.

Taiwan has had strict environmental regulations covering electronics and home appliances since 1998. The rules require payment of recycling fees based on volume or products marketed. These fees are used to collect and recycle products covered in the regulations. The rules also call for strict auditing. The Taiwan Environmental Protection Administration has developed an ambitious three-year Environmental Act Initiative program that covers toxic chemicals and emissions reduction.

But J.S. Yang, deputy director of the Center for Environment, Safety and Health at the Industrial Technology Research Institute (ITRI), says the three-year plan for the control of toxic chemical substances doesn't take RoHS-related issues and chemicals into consideration. "Actually, the Toxic Chemical Control Act of Taiwan EPA focuses only on the source control of the chemicals on the list, covering manufacturing, importing, and usage of 263 chemicals," says Yang.

According to Yang, Taiwan's Solid Waste Management Bureau, based on the country's Solid

Waste Control Act, will regulate or control specific chemicals in products. He adds that Taiwan EPA and the Minister of Economic Affairs have discussed the formulation of Taiwan-RoHS regulations in the past two months. "I personally believe that the international trend, the requirements from OEMs and ODMs [original design manufacturers], and the pressure from local environmental groups will force the government to take some solid action," he says. However, it could take up to two years for Taiwan and South Korea to develop their own RoHS-compliant regulations.

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Chapter 3: Playing By The (New) Rules— The Industry's Response To RoHS

by Ron Schneiderman

Constitution or no constitution, you still have to comply with the European Union's (EU) Restrictions on Hazardous Substances (RoHS) by the middle of next year. The EU's attempt to create a United States of Europe, as a few political pundits have put it, has already been quashed by French and Dutch voters. But this doesn't affect the EU's new environmental legislation.

Tracking RoHS compliance is tricky, but the news continues to be mixed. Most major OEMs and chip manufacturers are, or soon will be, fully compliant with RoHS, putting them well ahead of the deadline. This also is true of many smaller companies.

Artesyn Technologies, producer of power-conversion and embedded board solutions for telecom infrastructure applications, says its Communications Products Division will ship its first RoHS-compliant products in August. The company's Power Conversion Division will fall into line by the end of the year.

Most telecom infrastructure equipment is exempt from RoHS rules. Yet Kirsten Koegel, Artesyn's marketing manager for RoHS issues, says the exemption is for lead in the solder of products used in telecom applications. "Some of Artesyn's customers are requiring the use of leaded solder in the products they take from us. Others want RoHS compliance without exemption (a lead-free soldering process)," she says.

A few laggards still may have trouble playing catchup before the July 1, 2006 deadline. Many smaller companies continue to be confused about the rules. And they have less than a year to figure it out.

"Every company in the electronics supply chain, from parts manufacturers to retail outlets, needs to have strategies to comply with these regulations," says a report by AMR Research.

Leonie Tipton, vice president of supply-chain programs for Arrow Electronics, sees RoHS as just another challenge for the supply chain. "We're trying to help our customers with information, interpretation of the rules, data and tools, and how they should manage their compliant parts. We think there are some best practices that we can share," Tipton says. "There are still a lot of companies trying to work out what this means for them, particularly given the ambiguity of the legislation, but also the exemptions."

OEMs, in particular, are aggressively working to meet the RoHS deadline. Eric Williams, manager of Texas Instruments' Eco-Friendly Solutions Program Office, describes RoHS compliance as an evolutionary process for OEMs. "Most OEMs have come to understand the (RoHS) requirements over the last six to nine months. Our customers are putting their plans in place to be compliant next year," he says.

Dell recently updated its environmental policy and said it would now avoid the use of lead and brominated flame retardants in its products in response to RoHS. Hewlett-Packard doesn't use many of the substances listed in the RoHS directive, but it has updated its internal environmental program to include interim RoHS language. IBM is adding elements of the RoHS directive to IBM-Parts, its global parts management relational database. Sony and Apple also are well along in the

process of meeting RoHS requirements, as are most other PC and consumer electronics OEMs.

MANAGING PARTS

"One of the critical issues is managing new materials, and a big part of that is part numbering, just trying to avoid mixing the leaded and lead-free devices," says TI's Williams.
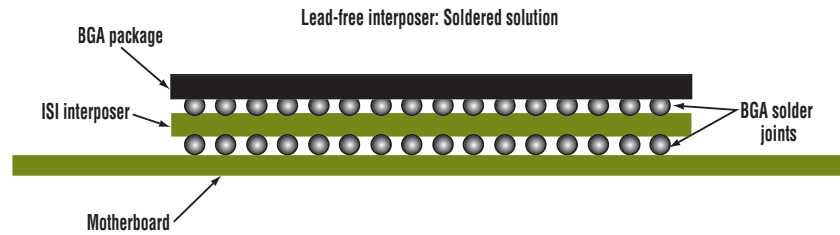
TI has adopted the JEDEC standard for tracking its 50,000 different component products, while many other chip manufacturers have developed their own numbering system. Some companies said they have no plans to change their part numbers when they're lead-free. The lack of any industry parts numbering standard, says Williams and others, may eventually cause real problems, especially for OEMs, even though many companies have communicated their intentions to customers.

"There's a lot of logistics involved and companies are changing their processes," says Paul Chantalat, vice president of quality and reliability at Linear Technology. In most cases, companies are converting to lead-free production by division or by product line, not throughout the entire company.

Concerned about mixing shipments and misprocessing parts, Linear Technology has inspection systems at both the outgoing and incoming assembly points and is doing x-ray fluorescence inspections to ensure that its plating is lead-free. (Artesyn Technologies, like other companies, is still collecting material content data from suppliers and qualifying parts based on customer surveys. Artesyn also is developing an analysis tool for engineering and, like other companies, is generating material content reports for its own products.)

3-1. Interconnect Systems has developed at least two options for using lead-free solder paste. One case attaches the interposer to the motherboard with 63/37 solder paste. The other attaches the interposer to the motherboard with lead-free solder paste.

Interconnect Systems says that while many of its customers are exempt from lead-free and RoHS regulations, standard eutectic 63/37 BGAs will no longer be available. But it's getting a little complicated. ISI says pc-board assemblies have multiple BGAs from multiple suppliers that are phasing in lead-free packages at different times. In some cases, OEMs maintain several years of inventory of leaded BGA ASICs that were purchased as last-time buys.

To help solve this problem, ISI offers interposers with lead-free BGA soldered to the top side of the interposer using lead-free solder paste and leaded 63/37 balls on the bottom side. The customer can attach interposer to the motherboard with 63/37 solder paste *(Fig. 3-1)*. Another option is using interposer with 63/37 BGA soldered to the top side and lead-free balls on the bottom side, and the customer attaches interposer to the motherboard with lead-free solder paste.

TIN-WHISKER TALK

Not everyone is moving in the same direction when it comes to replacing lead. This invariably leads to talk of tin whiskers, a phenomenon that can blow out components and cause system failures, including electrical shorts and heat swings in orbiting satellites and other systems.

As a result, OEMs face myriad lead-free choices. TI, Agere Systems, National Semiconductor, Toshiba America Electronic Components, and chip designers and manufacturers that are much smaller are using different (and in some cases, a variety of) alternative materials to replace lead in their components.

Matte tin has some associated issues, mainly from military and telecom customers who generally use their equipment in the field and over long periods of time. Yet "going to matte tin is a slam dunk," says Chantalat of Linear Technology. "We have generated enough reliability data to convince our customers that matte tin is a reliable alternative."

The International Electronics Manufacturing Initiative (iNEMI) has released two documents to help manufacturers reduce the risk of tin whiskers in lead-free products. One is JEDEC standard JESD22121, Test Method for Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes. The other is an updated Recommendations on Lead-Free Finishes for Components Used in High-Reliability Products from the iNEMI Tin Whisker User Group. (JESD22A121 can be downloaded for free from the KEDEC Web site at *www.jedec.org* or *http://jedec.org/download*.)

Technically, the jury is still out on lead alternatives, and it may be out for a while. C.P. Wong, a Regents professor in Georgia Tech's School of Materials Science and Engineering, has been studying a variety of materials that might replace lead, including tin-based solders and electrically conductive adhesives. He says these materials aren't yet as good as the lead-based solder they're designed to replace. Still, there has been significant progress made toward developing alternatives to remove lead from electronic products *(Fig. 3-2)*.

"Before these alternatives become truly viable, we must develop conductive adhesives that can carry high currents, and lead-free solders that have low processing temperatures, high reliability, and good thermal-mechanical properties," notes Wong.
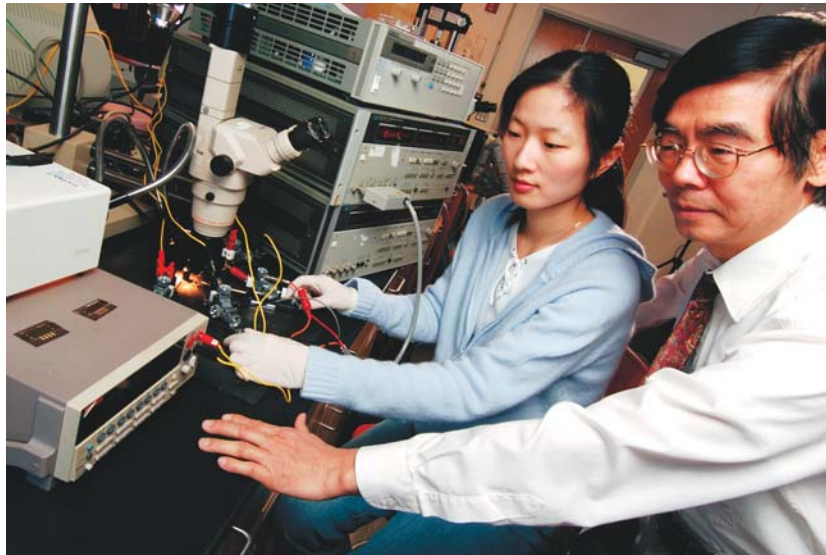
Tin-lead alloys have long been used in interconnects on pc boards in a broad range of devices, mainly because they have a low melting point, are highly reliable, and have good mechanical properties.

3-2. Researchers C.P. Wong (right) and Grace Yi Li test properties of electrically conductive adhesives in their Georgia Tech laboratory. (photo by Gary Meek, Georgia Tech)

Lead-free solders that combine tin with other metals such as silver, copper, bismuth, zinc, indium, and nickel are already in use. Wong says that an alloy composed mostly of tin, but to which silver and copper have been added, has been widely accepted as the most promising lead-free solder. However, the melting point of this alloy (217°C) is about 30°C hotter than that of the tin-lead alloy with the lowest melting point (183°C). Processing at the higher temperature creates potential manufacturing problems.

"When you attach a component to a circuit board in a cell phone or PDA using this alloy, you would subject the components to a higher temperature, which increases unwanted stress and reduces the integrity, reliability, and functionality of the equipment," Wong says. He suggests the temperature problem could be addressed by the introduction of metal nanoparticles into the tin-based solder.

Electrically conductive adhesives offer another alternative. They consist of metal powder filler, usually silver, that conducts electricity inside a polymeric resin. The resin, an epoxy, silicon, or polyimide, provides mechanical properties such as adhesion, mechanical strength, and impact strength.

Even so, Wong says electrically conductive adhesives have their own set of disadvantages, including conductivity fatigue, limited current-carrying capability, and poor impact strength. "However, progress is being made at improving the properties of these materials," he says.

TESTING SERVICES

RoHS also has generated new opportunities for independent consulting and test services. That's

partly because companies have found that it is more expensive to do their own testing and auditing than farm it out.

There could be other reasons, though. According to an online survey conducted by TUV Rheinland of North America, more than half of the manufacturers that responded didn't know what they needed to do to comply with RoHS. With the survey results in hand, the product testing and certification service developed a consulting service for RoHS compliance and began holding custom seminars globally for OEMs.

Wyle Laboratories also picked up its RoHS-related product testing business, much of it from mobile phone manufacturers. "Wyle OEM customers want to display 'Wyle Labs Certified' labels on their products, along with their self-declarations of RoHS compliance," says Don Smith, Wyle's manager of commercial test services.

Underwriters Laboratories has a full-blown consulting and testing program that includes a massive database of RoHS-compliant parts. The organization has been staying on top of RoHS developments since it was first proposed by the EU.

"Companies are getting very nervous as the (RoHS) deadline approaches," says Max Elbaz, who manages the UL program. "Mid- and small-size companies will have a hard time complying by the deadline, and this will put a lot of strain in the supply chain for OEMs who want to have a ready supply of components. This could mean people will be taking some shortcuts."

Elbaz also sees companies taking major writeoffs in 2005 and 2006 as some of their products become obsolete before they can be moved out of inventory and into the market. Anticipating this, he says, many companies will try to push these "last buy" products out the door well before the July 1, 2006 deadline, when all they can deliver is RoHS-compliant products.

TRADE GROUPS BUSY

Trade groups also are stepping up their standardization activities as they try to help their member companies respond more efficiently to the RoHS directive. The Electronics Industries Alliance (EIA), the Japan Green Procurement Survey Standardization Initiative (JGPSSI), and JEDEC have jointly announced the publication of the first international standard for product material content reporting. The Joint Guide for Material Composition Declaration for Electronic Products (Joint Industry Guide, or JIG) is expected to enhance and harmonize the reporting of standardized approaches for the disclosure of material content data across the entire electronics supply chain.

Developed by the EIA and JGPSSI using JEDEC procedures, the guide represents the first industry step toward disclosing material content data. According to the EIA, the standard was motivated by the increasing trend toward international environmental regulations that restrict the use of certain substances in electronic products, mainly the European Union's RoHS.

"The guide will provide a standardized list of relevant materials that require supply-chain disclosure and will make this process more management- and cost-effective for all members of the global electronics supply chain," says Dave McCurdy, EIA president.

The guide provides a standardized list of materials that must be disclosed when they are present in products and subparts that are supplied to electrical and electronic equipment manufacturers for incorporation into their products.

According to the EIA, the new guide was not developed to provide information on every material in a component or final product. Rather, it was designed to standardize manufacturer reporting on those materials that are relevant to the global electronics supply chain. The guide also does not preclude companies from inquiring about the presence of additional substances. It will be revised as regulatory or market requirements evolve. To receive the guide free of charge, visit *www.eia.org/jig*.

Another trade group, IPC, has developed a family of supplier declaration standards, two of which are in draft form. IPC-1751, Generic Requirements for Declaration Process Management, describes all generic requirements, including company information. IPC-1752, Materials Declaration Management, outlines a supply-chain materials declaration format and process that provides a simple approach for companies in meeting environmental regulation compliance.

The draft standards were released on June 10, 2005 for a 60-day industry review. They can be accessed at *www.ipc.org/IPC-175X*. Once all feedback has been reconciled according to the Ameri-

can National Standards Institute (ANSI) standards approval process, the standards will be issued.

IPC, iNEMI, and RosettaNet have been working for over a year to simplify and standardize how the industry collects, tracks, and discloses product material content information. RosettaNet is an e-business process consortium and a subsidiary of the Uniform Code Council, whose members include Agilent Technologies, National Semiconductor, NEC Electronics, Nokia, Sony, STMicro-electronics, and Texas Instruments.

COUNTERFEITING AN ISSUE

As if the industry didn't have enough problems with RoHS, counterfeiting could turn out to be another consequence of the directive. Robin B. Gray Jr., executive vice president of the National Electronic Distributors Association (NEDA), expressed his concerns in a newsletter item published by the group. He said that while companies initially focused on leaded inventory being dumped into the marketplace at distressed prices, leaded parts marked as lead-free may enter inventories once RoHS becomes law.

"In most instances," says Gray, "it will be difficult, if not impossible, to distinguish the lead-free part from the leaded part without expensive lab testing. That situation leaves the door wide open for unscrupulous marketers to sell leaded parts as lead-free." This can take many forms, such as leaded and lead-free parts being mixed together.

"If there is a bright spot in this whole RoHS mess," adds Gray, "it is that customers should become more reluctant to make spot and production buys from anyone other than an authorized distributor or direct from the manufacturer. Anything else runs the heightened risk of getting coun-terfeit parts or significant testing costs."

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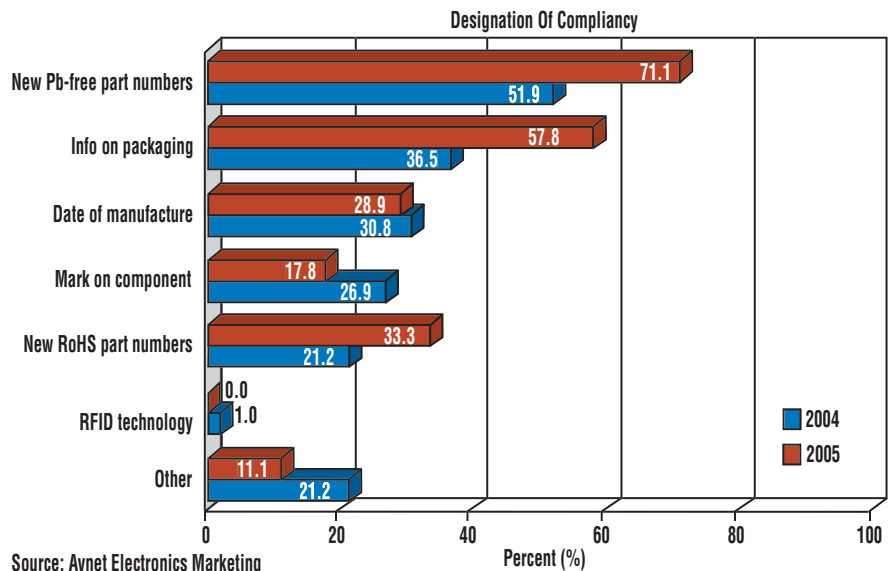# Chapter 4: RoHS Compliance And Transition Issues

by Ron Schneiderman

Has everyone who should comply with the European Union's Restrictions on Hazardous Substances (RoHS) directive actually done so? According to several industry sources, consultants, analysts, and two new surveys, not nearly everyone is in compliance.

Take it from those who have been working this issue from the beginning. If you don't make the July 1, 2006 deadline, you will pay for it in one way or another. You could experience lost business, fines, or other penalties levied by individual (and possibly multiple) EU member countries, not to mention possible damage to your brand and your corporate image.

"For American companies, inadequate knowledge and preparation for RoHS can also result in further penalties under the Sarbanes-Oxley statutes," says Max Elbaz, who heads Underwriters Laboratories' Restricted Substances Compliance Solutions Program (RSCS). Congress passed Sarbanes-Oxley (SOX) nearly four years ago in the wake of several corporate scandals. To help companies avoid getting into this kind of trouble, UL has developed a comprehensive testing and surveillance program tied into a massive database of compliant parts. The organization also has been advising a growing list of companies on RoHS compliance.

However well intentioned, RoHS is turning out to be a time-consuming and costly burden for the electronics industry. Some industry companies—all too many by several accounts—have been slow to comply and slow to grasp the needs of the critical elements required in the supply chain.

Designation Of Compliancy

New Pb-free part numbers: 71.1 / 51.9
Info on packaging: 57.8 / 36.5
Date of manufacture: 28.9 / 30.8
Mark on component: 17.8 / 26.9
New RoHS part numbers: 33.3 / 21.2
RFID technology: 0.0 / 1.0
Other: 11.1 / 21.2

2004
2005

Source: Avnet Electronics Marketing

Percent (%)

4-1. Only 71% of the component suppliers surveyed by Technology Forecasters for Avnet Electronics Marketing plan to use new part numbers for their lead-free products.

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INDUSTRY SURVEYS

Most contract manufacturers, component manufacturers, and OEMs are moving toward RoHS compliance. Evidence comes from a preliminary interpretation of results from a new survey by Technology Forecasters and Avnet Electronics Marketing on the status of the industry's preparedness for complying with RoHS legislation compared to a similar survey conducted in late 2004. But there are still some laggards on key issues.

RoHS Activities

Designing components — 2004: 90.4, 2005: 73.3

Percent (%)

Source: Avnet Electronics Marketing

4-2. The Technology Forecasters/Avnet survey suggests that about 90% of the respondents were already designing RoHS-compliant chips in 2004.

Only 71% of the component suppliers surveyed by Technology Forecasters/Avnet plan to use new part numbers on their lead-free products *(Fig. 1)*. These numbers can take the form of a simple suffix added to the original part number, or they can be an entirely new part number. OEMs in particular have already indicated that they would prefer their suppliers to use new part numbers on their RoHS-compliant parts.

"That's one of the metrics we were hoping would improve, but it still isn't quite where we want it," says Jim Smith, vice president of logistics for Avnet Electronics Marketing. "We are still concerned that suppliers are underestimating the supply-chain implications of this issue."

More than half (57.8%) said they plan to add information to the packaging of their lead-free products. Additionally, the survey indicates that about 90% of the respondents were already designing RoHS-compliant chips in 2004 *(Fig. 2)*. Early results of the 2005 survey also show that nearly 29% expect to have potentially obsolete parts in their inventories in July 2006, the deadline for RoHS compliance, while 31% still have no plans for handling these "excess" parts *(Fig. 3)*.

Further preliminary data indicates that most supplier respondents do not foresee price increases as a result of RoHS. Nor do they expect supply-chain disruptions due to inventory excess or a shortfall of affected parts. "We hope the suppliers are right about that," says Smith. "However, with hundreds of thousands of parts changing as a result of these requirements, we are not ready to declare victory just yet. There is still a huge amount of work for the industry to do."

Design Chain Associates LLC, an independent consulting firm for OEMs that focuses on supply-chain issues, conducted another survey recently. It covered nearly 2000 attendees of RoHS seminars it conducted using its Web-based tools as well as those of EPTAC Corp. Only 5% of the respondents indicated that they have not started complying with RoHS, and most of those are battery manufacturers or companies with otherwise exempt products. On the other hand, DCA president Michael Kirschner says only two respondents, or a statistically insignificant 1% of the survey, claim to have actually completed the compliance process. According to Kirschner, half of the other respondent companies remain at the investigation and planning stage.

"This group faces some significant challenges but is still far ahead of those who can't even spell R-O-H-S," Kirschner says. "There will be a panic setting in among the significant fraction of most smaller OEMs and suppliers" that have minimized the impact of not taking the RoHS directive more seriously. But why the slow response? Kirschner thinks there are three reasons.

One is ignorance. "The EU did a terrible job of notifying the industry what was, and is, coming so it was effectively done by word of mouth," says Kirschner. Funding is another issue. RoHS effectively "snuck up" on the industry to the extent that hardly anyone could budget for it. This reactive approach means that "only those products or product lines that customers jump up and down and scream about have any effort being put in to them to make them compliant." Then, there are the rules, which have been a moving target. "The information is scattered all over the place. There's no one place you can go for definitive information. As consultants, we're more up on what's going on that most, but the EU is not making it easy," says Kirschner.
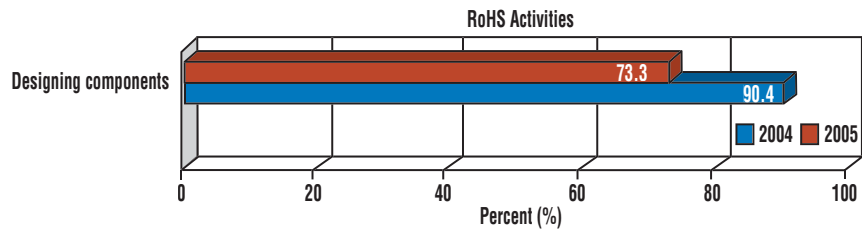
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TO EACH HIS OWN

As might be expected, most larger companies—Texas Instruments, Hewlett-Packard, Dell, National Semiconductor, Avnet Electronics, Arrow Electronics, and others—fully expect to meet the RoHS compliance deadline. For component suppliers, the first trick is to understand the regulations. Then it's planning and developing compliant components, manufacturing the new components, and qualifying compliant parts, which includes matching customers and supplier preferences. In addition, component suppliers must develop a set of compliance documents (a process that has not been standardized), then submit data to customers.

Agilent Technologies Semiconductor Product Group, for one, has been and will continue converting various versions of its products to lead-free versions. Some of Agilent's products may remain available in both leaded and lead-free options during a transition period.

Tundra Semiconductor has offered lead-free packaging for most of its system interconnect products for about a year. The same is true of STMicroelectronics, Infineon Technologies, Philips, and Motorola subsidiary Freescale Semiconductor, which announced its acceleration toward lead-free devices in June 2004.

Companies face as many management issues as technical issues. One of the more timely problems for chip suppliers, which many semiconductor vendors seem to still be wrestling, is forecasting run rates as their customers switch to lead-free devices. "We see this as a big issue, and it could increase costs," says Cindy Newell, tactical marketing manager at programmable-logic specialist Actel Corp. and the company's resident lead-free/RoHS expert.

As for supply-chain management, several industry groups have led the way in helping their member companies and the industry meet RoHS requirements. The RoHS Transition Task Group initiated the four main project working groups, and the iNEMI Tin Whiskers User Group has researched and shared information on whisker formation in tin platings and material declaration for lead-free assemblies.

A very large number of companies also has participated in—and continues to rely on—other groups. These include standards organizations JEDEC (Joint Electron Device Engineering Council) and the EMS Forum, which published common supply-chain requirements that contact manufacturers can follow as they transition to RoHS compliance. For additional information, check "RoHS: Industry And Government Contacts Of Interest" on this Web site, *www.elecdesign.com*.
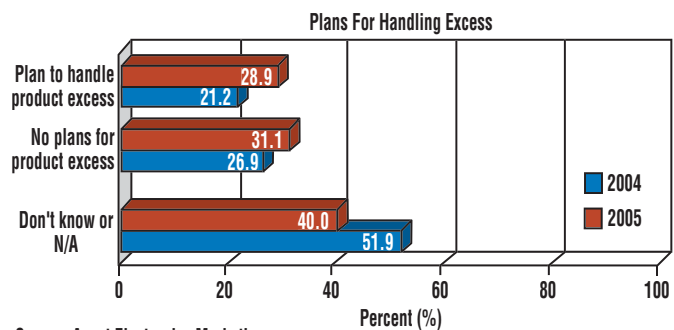
Another hot topic continues to be which solder to use. The IPC Solder Products Value Council (and of course, several companies working independently) claims to have already done the research through its lead-free test program. The answers are in the IPC's new "Final Report—Round Robin Testing and Analysis of Lead-Free Solder Pastes with Alloys of Tin, Silver and Copper."

The report answers two key questions. What alloys will most likely be used as tin lead solder replacement? And what tests can accurately determine the differences, if any, in the properties of the most likely candidates?

The council determined that the majority of potential "standard" replacement alloys consists of tin, silver and copper (commonly called SAC) alloys. It also analyzed the three most commonly used lead-free alloys:
1. 96.5/3.0/0.5 tin/silver/copper
2. 95.5/3.8/0.7 tin/silver/copper
3. 95.5/4.0/0.5 tin/silver/copper

Test methods used in the research included DSC melt analysis, wetting balance, area of spread,

Plans For Handling Excess

Plan to handle product excess: 28.9 (2005), 21.2 (2004)
No plans for product excess: 31.1 (2005), 26.9 (2004)
Don't know or N/A: 40.0 (2005), 51.9 (2004)

Percent (%)

Source: Avnet Electronics Marketing

4-3. Nearly 29% of the Technology Forecasters/Avnet survey respondents expect to have potentially obsolete parts in their inventories in July 2006, the deadline for RoHS compliance.

visual inspection of solder joints, x-ray analysis of solder joint voids, temperature cycle testing, thermal shock testing, and metallurgical analysis.

The final 50-page report also includes summary findings on the effect of voiding on solder joint reliability. Although the research project wasn't designed as a head-to-head comparison of lead-free versus tin lead solder, because tin lead solder was used as a control, the report highlights solder joint performance based on package type.

PRODUCT LABELING

Agilent Technologies' product labels may include "Pb free" as a distinguishing mark. Agilent may also change its part numbers for its lead-free parts.

Most Coilcraft parts now come in an ROHS-compliant version. Many are available off the shelf, but others could have a lead time. Coilcraft intends to have inventory of all standard RoHS-complaint products by August 1, 2005 and then discontinue old part numbers after that.

Coilcraft plans to use the letter "L" to positively identify its parts as RoHS-compliant. This is a change from the company's previously announced plans.

Total Parts Plus, an obsolescence tool provider, has expanded its material content database for electronic and non-electronic components to more than 2.5 million part numbers, including information with RoHS compliancy flags, exemption tracking, compliant alternatives, tin whiskering data, and reflow temperature data.

Amulet Technologies, a privately held fabless semiconductor company, has announced an RoHS-compatible version of its graphical user interfaces (GUIs).

The International Electronics Manufacturing Initiative, or iNEMI, says that the majority of OEMs and contract manufacturers strongly supports the use of unique part numbers for RoHS-compliant components. Jim McElroy, executive director and CEO of iNEMI, states that many iNEMI members feel very strongly about this issue and have asked the organization to go on record as supporting separate part numbers. Some manufacturers have opted for lot codes rather than unique part numbers. Others will simply stamp their products with a date of manufacture, which may create problems for OEMs not in a standard format.

In fact, about 29% of the supplier-respondents to the Technology Forecasters/Avnet survey said they plan to use a date of manufacture to designate their RoHS compliancy. Technology Forecasters and Avnet also have conducted a customers survey. Its results will be available soon.

HELP DESK

Some design engineers and component buyers remain confused about what's required of them. Fortunately, help is available through new tools developed to ease the way through the undeniably complicated RoHS compliance process.

Newark InOne, a small-quantity distributor of electronic components and test equipment, has developed RoHS Express. This comprehensive, online resource was designed to help smooth the way with critical RoHS information.

"While the RoHS buzz has escalated recently on this side of the pond, there has been a lack of real specifics," says Paul Tallentire, Newark InOne's president. "We dubbed RoHS Express as the 'fast track to compliance,' as it gives our customers quick, precise answers to their most important questions."

Some companies also have developed specific tools to help others comply with RoHS. For example, Arrow Electronics has expanded its Component Information Services, an online toolset that provides engineering, procurement, and supply-chain data with information on the environmental status of 5 million parts. In addition to identifying RoHS and lead-free compliance status, the expanded service enhancements announced by Arrow include manufacturing parameters and hazardous material composition data for semiconductors, electromechanical, and passive components.

Synapsis Technology has focused its efforts on lead-free design. Its patent-pending Environmental Material Aggregation and Reporting System (EMARS) is an off-the-shelf solution that offers a complete set of functionality to analyze and track compliance at the substance, material, part, and product level, as well as manage the data collection and reporting process. Tallentire says it also

maximizes the visibility of compliance transition at all stages of the product life cycle, minimizing the risk and cost associated with noncompliance.

Omnify Software, a specialist in product-lifecycle-management (PLM) software, also has developed a software package to help OEMs manage RoHS materials restrictions and requirements. The company says the product can help engineers and purchasers select and manage the right suppliers and components during the product design process and throughout the entire product lifecycle.

Niron LLC has introduced the handheld XLt Analyzer to test for lead-free solder in RoHS-compliant components. Thermo Electron Corp. has a range of atomic absorption spectrometers to analyze trace materials, including those covered in the RoHS legislation.

Artysyn Technologies, a designer and manufacturer of power-conversion and single-board computing products for telecom applications, says it has developed an analysis tool for engineering and generating material content reports for its own products. Meanwhile, iNEMI has been urging designers to develop a comprehensive and standardized framework or "quick reference" system to determine the environmental status of any substance. iNEMI's 2004 Conscious Electronics Roadmap also calls for the industry to get more involved in making policy on materials restrictions so policy makers will understand the tradeoffs inherent in material substitution.

Although this may seem a little late in the game, questionnaires are being sent to suppliers requesting detailed information on what chemicals are used in their products. This suggests to many industry sources that the RoHS requirement for the elimination of only six, albeit critical, materials may be just the beginning.

Texas Instruments, like many other component suppliers and OEMs, has formed a full-time team of resident experts on RoHS. TI also provides detailed technical information on RoHS on its Web site through its Eco-Friendly Solutions Program Office.

Finally, Association Connecting Electronics Industries and JEDEC have scheduled a conference on lead-free electronic components and assemblies for August 17-19 at the Grand Hyatt Hotel in Singapore. This meeting will focus on lead-free reliability and manufacturing, the global soldering standard, impacts on RoHS on electronic products, an overview of J-STD-001D, and lead-free system compatibility.

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Chapter 5: A Review Of Environmental Proposals In The U.S.

by Ron Schneiderman

While American electronics companies have been rushing to comply with global environmental laws, the U.S. Congress and state legislatures are wrestling with who should be responsible for recycling electronic waste and with how to protect the public from hazardous materials found in electronic products.

The U.S. has no federal or national environmental laws or regulations equivalent to the European Union's (EU's) Restrictions on Hazardous Substances (RoHS) or Waste Electrical and Electronic Equipment (WEEE) directives. Yet electronics has become one of the fastest growing areas of the recycling industry.

The International Association of Electronics Recyclers (IAER) estimates that about 130 million mobile phones will be discarded this year, while 250 million PCs will become obsolete in the next five years. John Stephenson, director of resources and the environment at the Government Accountability Office (GAO), in recent testimony before a U.S. Senate committee, said, "Some data suggest that over 100 million computers, monitors, and televisions become obsolete each year and that this amount is growing."

That's a big number, and it doesn't include the 80 million TV sets that could become obsolete as TV broadcasters transition from analog to digital broadcasts. If Congress gets it way, U.S. consumers will have to switch to digital TV by January 1, 2009. Consumer advocates note that about 15% of U.S. households rely on over-the-air television signals and are asking Congress to help these TV owners obtain special converter boxes.

Help may be on the way in the form of several proposed laws floating around Congress. At the same time, some 26 states have proposed nearly 50 e-waste bills. But so far, only four states have passed e-waste/recycling laws. New York City is considering a fairly ambitious recycling legislative package of its own, specifically targeting electronic products. A few other states have introduced legislation that calls for simply studying the problem.

Most of these bills aren't expected to come up for a vote until sometime next year. "Some of these proposals aren't likely to go anywhere, mainly because of heavy lobbying," says Kim Leslie, director of content for Raymond Communications, which tracks global environmental laws and activity. She also anticipates slow progress because many of the laws are unclear and don't address the problem very well.

Mark Murray, executive director of Californians Against Waste (CAW), also isn't very hopeful that much will happen at the federal level, at least not anytime soon. "The best we might see out of Congress will be an extension of existing manufacturing investment tax credit legislation to recycling enterprises," he says.

FEW WINNERS

State e-waste legislation is taking various forms. In takeback programs, manufacturers may

bear the cost of collection, consolidation, and transportation of discarded products. (In the U.S., most larger companies have takeback programs of some type or are contributing to consumer collection programs in the U.S.) The advanced recycling fee (ARF) model requires a fee that is usually defined up front and collected at the time of sale. Each of these business models has advantages and disadvantages.

Parker Brugge, senior director and environmental counsel to the Consumer Electronics Association (CEA), says the takeback model maximizes the incentive to minimize recycling costs because recycling costs go directly to the bottom line. It also provides some incentive for OEMs to design new products in a way that reduces recycling costs. Additionally, the takeback scheme allocates responsibility among consumers to deliver their ready-to-be-recycled products to collection points, to local governments to operate collection points, and to manufacturers to manage recycling operations.

One disadvantage of the takeback system, according to Brugge, is that collection costs serve as a selective tax on manufacturing. It also usually means that consumers end up bearing the cost of recycling so-called historic products.

A potential advantage of the ARF model is that it permits contracting from a centralized entity, such as a government agency. It also offers potential economies of scale. Yet ARF lacks a design incentive for recycling new products. According to Brugge, ARF is unlikely to provide direct manufacturer participation in the recycling system. It increases the cost of new products to pay for recycling old products. Also, it reduces any incentive for manufacturers to incorporate recycling into their overall business process.

WEEE AREN'T

Industry companies have been busy trying to respond to the EU's RoHS directive, which becomes law on July 1, 2006. But they have been much slower to respond to WEEE, even though the official deadline passed on August 13.

"Many manufacturers are unaware, poorly informed, or confused about the requirements and implications regarding preparation of WEEE compliance," says Leonie Tipton, vice president of Global Supply Chain Programs at Arrow Electronics. In fact, several EU member countries still aren't on board with WEEE, having not yet finalized their own EU-required WEEE legislation.

The U.K.'s Department of Trade and Industry has extended the date for collecting and recycling electronic waste in the U.K. to June 2006. The DTI says it needs more time to establish a working network of facilities for separate collection of e-waste for homeowners. However, new products launched in the U.K. after August 13 must identify the producer and show a date in some way. Meanwhile, China's State Environmental Protection Administration says it was in full compliance with WEEE before August 13.

WEEE requires electronics manufacturers and "producers" to financially support takeback programs for the collection, treatment, and recycling of end products sold in EU member states, as well as Norway and Switzerland. WEEE defines companies that sell equipment using their brand name on equipment made by another manufacturer as a producer. Producers have the same responsibilities as manufacturers.

WEEE also lets producers comply either individually or collectively by joining what the EU calls a "compliance solution organization," which would be a membership-based organization equipped to comply with the directive. Under WEEE, professional recyclers would likely collect the majority of WEEE-related products from local authority waste sites. WEEE products can be collected from municipal waste sites or local collection points, but not from consumers.

To help speed the adoption of WEEE, Salt Lake City-based RecycleNet Corp. operates a secondary commodity exchange *(www.recycle.net)* for all types of scrap materials, including electronic scrap. "We're an exchange system, sort of like NASDAQ, where buyers and sellers can find each other," says Paul Roszel, RecycleNet's chairman and CEO. He says his company typically handles $200 million in transactions every day. "Electronics now represents the fastest growing share of scrap collections," he adds.

RecycleNet, which operates globally, has established a series of grades and specifications to aid in the collection, sorting, and trading of WEEE scrap. It has segmented WEEE scrap into four groups designated by the letters M, F, B, and C. The M group includes all items with a cathode ray tube (CRT). Group F consists of all items with a flat-screen display (such as LCD or plasma technology). The B group includes all items that contain a battery (excluding those items with monitors or flat screens). Group C comprises items with an electrical cord with no monitor, flat screen, or battery.

Each of the four groups is then subdivided into classifications by weight. These classifications are separated by items that weigh less than 10 lb, items that weigh 10 to 50 lb, and items over 50 lb. In addition, grades and specifications have been established for Poly E-Scrap to facilitate the recycling of mixed plastics from electronics. The grades and specifications are available online at *www.weeescrap.com*.

RecycleNet also has formed Scrap China Corp. and plans to set up a base of operations in Beijing to facilitate the international trade of secondary commodities. Roszel says he now has more than 5000 customers in China.

CONSUMER CONFUSION

Laws or no laws, consumers are as confused as ever about what to do with their e-waste. Research sponsored by Hewlett-Packard and conducted by Penn, Schoen and Berland Associates shows that 95% of American consumers don't know the meaning of the term "e-waste," and 58% are not aware of an e-waste recycling program in their community.

"Our research found that while nearly three out of four consumers have used or unwanted technology products in their homes, they aren't sure how to dispose of it," says David Lear, vice president for corporate, social, and environmental responsibility at HP. Another survey by ACNeilsen International Research commissioned by eBay and the Silicon Valley Toxics Coalition found that 56% of American households have unused working electronic products, and 25% of this group have an unused, working cell phone.

At the federal level, U.S. Senators Jim Talent (R-MO) and Ron Wyden (D-OR) have introduced legislation (S510) that would give an $8-per-unit tax credit to companies that recycle at least 5000 display screens or computer system units each year. A bill (HR425) introduced by California Rep. Mike Thompson would establish a fee-based bill similar to the law passed in California. Legislation (HR320) introduced by Rep. Randy Cunningham (R-CA) also would give manufacturers tax incentives to recycle.

Legislation introduced by Rep. Paul E. Gilmor (R-OH) that would regulate the transportation of international waste has cleared the House Energy and Commerce Committee by unanimous vote and is ready for action by the full House. Although it's not clear how much of it was e-waste, Gilmor says the U.S. has received more than 3.7 million tons of trash from Ontario, Canada, alone.

"This is garbage that must be stored in landfills which our sates and communities went to great expense to create," says Gilmor. He notes that his legislation doesn't ban waste shipments or stop communities from accepting international waste, but it does allow states and the U.S. Environmental Protection Agency (EPA) to control the importation of waste into the U.S.

CALIFORNIA RULES

Most environmentalists agree that California has the most effective e-waste/recycling law in place in the country, at least for now—and none too soon. According to the California Integrated Waste Management Board, just over 8 million pounds of electronic products were recovered in the state in the first quarter of this year. That should increase, as some recyclers haven't completed their paperwork.

California's Electronic Waste Recycling Law (SB20) requires state residents to pay an up-front fee that would underwrite an e-waste collection and recycling program beginning in January. But legislatures realized the language of the bill didn't hold up enough to support its intent and passed SB50 to clarify the new law. When California consumers purchase a TV set or computer monitor in the state, they now must pay a fee ranging up to $10. The money goes to the state and is distributed to

groups or local governments that collect the discarded equipment and recycle it.

Money collected from consumers is sent to the state quarterly. The State Board of Equalization collected more than $15.7 million in fees for sales in the first quarter of this year. Californians Against Waste expects first-year fee revenue from the law to reach about $72 million.

The other e-waste/recycling laws include Maine's Computer Monitor Recycling Law PL661, Maryland's Computer Recycling Pilot HB575, and Maryland's PBDE Ban HB83, which would ban the use of polybrominated diphenyl ether. Minnesota's 115.9565 prohibits CRT disposal in mixed municipal sold waste.

Other states with pending e-waste/recycling and hazardous substances use legislation include:

Connecticut has proposed a bill banning PBDEs (SB785).

Florida has a bill for electronics disposal (SB674).

Hawaii has a law limiting PBDEs (HB2013).

Illinois has created a commission to review e-waste (HB1165) and is considering other legislation that would limit PBDEs (HB2572/SB424).

Massachusetts has introduced a bill covering the collection of e-waste (H1533).

Michigan is considering a bill to recycle CRT monitors (SB583).

New York is working on the Electronic Equipment Act (AO1454).

North Carolina has introduced bills for electronics recycling (H878 and S970).

Oregon's legislature is working on a bill that is very similar to California's, but it also has proposed the recycling of PBDEs (SB962).

Rhode Island has a bill for CRT recycling (HB5783).

South Carolina also has a bill for electronics recycling (S178).

Texas is promoting legislation for the disposal of e-waste (SB1239).

Vermont is trying to manage electronics equipment waste through legislation (HO343).

Washington's legislature has introduced two bills. One requires electronic product management (HB2488). The other regulates electronic waste (HB1942).

GETTING ON BOARD

Several OEMs and retailers are already on board with custom e-waste/recycling programs.

EBay has expanded its Rethink Initiative with the wireless market sector to provide "environmentally sound e-waste solutions" for unused or obsolete cell phones and other electronics. Texas Instruments' Eco-Friendly Solutions Program Office tracks and responds to environmental issues and laws.

Dell plans to expand its e-waste program globally by 50%. As part of this effort, it has provided three U.S. college and university customers $10,000 grants to conduct computer collection events on campus.

HP and Apple Computer also provide recycling services that enable consumers to obtain a shipping label and send equipment back to the company. Some companies offer this service for free, while others charge a very small fee, especially for customers buying new equipment from the same company.

Solectron, the giant contract manufacturer and designer, has formed an Environmental Compliance Team, mainly in response to the European Union's Restrictions on Hazardous Substances (RoHS) directive. But it also is tracking environmental efforts in the U.S. "It's a big challenge to keep up with state requirements," says Art Morgan, Solectron's director of technical marketing.

Sony Electronics has developed its Shared Responsibility Program, which promotes the recycling of consumer electronics in the U.S. by reducing the burden placed on consumers and local governments. Sony pays for the recycling of all own-brand products collected through many cooperative recycling events and has established collection points.

Canon U.S.A. has announced a Consumer Products Recycling Program to help U.S. consumers recycle Canon products. Under the program, consumers can order a UPS shipping label for a nominal fee by clicking on the "Recycle Now" button on Canon's recycling Web site.

Through Samsung Electronics' Eco-Partnership program, its suppliers can undergo a rigorous

Green Procurement Audit. Anadigics, which designs and manufactures RFIC products, has been promoting its certification under the Samsung program.

The CEA's strategy for its members' end-of-life products is to support federal legislation to avoid a state-by-state patchwork of laws governing e-waste and recycling. The association also opposes any initiatives that mandate direct manufacturer financing. It additionally supports market-driven environmental design initiatives such as environmentally preferable purchasing programs. "With takeback laws, OEMs will have to pass the cost onto consumers," says the CEA's Brugge. "Ultimately, the consumer will pay the bill."

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Chapter 6: Outlook For Future Environmental Policies

by Ron Schneiderman

The electronics industry should have seen the European Union's Restrictions on Hazardous Substances (RoHS) and Waste Electrical & Electronic Equipment (WEEE) directives coming. Electronic waste has been piling up for years, and even the most conservative recycling industry projections were starting to get scary.

The numbers are staggering. According to the Silicon Valley Toxics Coalition, if all consumers decided to throw out their obsolete computers at the same time, the country would face a "tsunami" of e-scrap. Projections by the coalition and California Against Waste suggest a huge increase in stored and recycled e-waste storage in the next 10 years. Something had to give, or go.

Although promulgated in Europe, the RoHS and WEEE amount to a de facto global environmental standard for the world's electronics industry. Even companies that don't do business in Europe will buy lead-free or otherwise RoHS-compliant parts and will have to certify that their parts meet RoHS standards.

Are we ready? Not quite. Just over half of the respondents to the recent *Electronic Design* Reader Survey said they were confident that their company would be compliant with RoHS by the July 1, 2006 deadline—a deadline that the EU has indicated will not be extended. Meanwhile, 60% of the contract manufacturers responding to a survey conducted in July by market research firm Technology Forecasters said they weren't even halfway through the process of becoming RoHS-compliant.

As a result, companies are working hard to ensure their compliance. They're forming teams of in-house environmental specialists, developing new materials to replace the restricted materials, adding new manufacturing equipment, changing part numbers and labels, re-evaluating their costs and pricing structures, and building environmental databases to help track the materials and products they use and sell to their customers.

Most OEMs, who are ultimately responsible for meeting the new environmental rules, have said they're already in compliance, or very close. That's even with competitive pricing and other pressures hanging over their heads.

One seemingly unexpected fallout from the transition to a lead-free environment has been a change in relationships between some distributors and their suppliers and customers. "We see customers changing suppliers," says Jeff Shafer, senior vice president of Newark InOne, a small-quantity distributor of components and test equipment. Shafer also says RoHS is presenting an opportunity for distributors to improve their market share by aggressively positioning themselves as RoHS experts, promoting early RoHS compliance, and getting their suppliers to do testimonials on their Web sites. Several manufacturers have pared their product sources via more one-stop shopping as well.

Industry sectors like the military, certain medical devices, and some areas of the telecommunications industry have won exemptions from RoHS. Also exempt are servers, storage and storage array systems, and monitoring and control instruments. Others are still pressing for exempt status. But those exemptions may turn out to be temporary as OEMs from the exempt sectors may soon have access to only "green," or lead-free, components.

Leaded parts will be available, at least for a while. "We plan to continue to offer the same leaded solder application we have now, in addition to the lead-free product," says Tony Garramone, corporate training manager at pc-board specialist Advanced Circuits. "The leaded solder will be available as long as it is practical, cost effective, and legal."

Tin whiskers are still an issue. The predominant whisker mitigation strategy for more than 50 years has been the addition of lead to the tin plating. As lead is eliminated from electronic products, many component suppliers are proposing the use of pure tin plating as the most convenient and least costly strategy for meeting RoHS requirements, according to the International Electronics Manufacturing Initiative (iNEMI). The pure tin strategy, however, presents reliability risks due to the whisker-forming tendencies of pure tin and tin alloy plating. This is especially true with the high-reliability user community, such as defense and aerospace. But military and aerospace contractors seeking noncompliant parts may eventually pay a premium for them or find new sources.

ARE WEEE READY?

Are you WEEE-compliant? Several of the EU's 25 member countries are not, which means they can't impose penalties without the legislation to enforce them. According to Max Elbaz, general manager of Underwriters Laboratories' Restricted Substances Business Unit, the only applicable penalties are those provided in domestic legislation. None are in the EU's WEEE directive. "If there is no legislation implementing WEEE, there will be no penalty," says Elbaz.

So far, 17 of the 25 EU member countries have adopted legislation. France, the U.K., Poland, Malta, Italy, Finland, Estonia, and Greece have not yet adopted WEEE legislation and have been "called to order" by the EU, as Elbaz puts it, for missing the deadline. The EU's final written warnings are the last step before the laggard member states are referred to the European Court of Justice.

Most countries have adopted a registration deadline, typically August 13, 2005, although some are late on this as well. The U.K. has set January 1, 2006 as its deadline for WEEE registration. "The problem," says Elbaz, "lies in countries that have adopted a deadline for registration but have failed to establish the mechanism that would allow for registration." For instance, he says a country could fail to establish a registration agency or to publish a registration form. "This is the case in a few countries, but we do not expect these countries to impose penalties under these circumstances."

With each of the 25 EU countries writing its own RoHS WEEE legislation, many companies fear they may have to follow 25 at least slightly different laws. Each industry sector has identified its own set of problems under RoHS. Fleck Research, a division of the Global Connector Research Group, says that while semiconductor manufacturers have modified the material for solder balls, substrates, and lead frames, it's still not clear to what degree the connector industry must follow suit.

Part numbers and labeling also continue to be an issue. According to Fleck Research, 42% of electronic component manufacturers moving toward RoHS-compliance don't plan to change their part numbers. Rather, they will rely on human-readable date-code data (to indicate the date of manufacture and, therefore, compliance). Otherwise, they will use other types of labeling to distinguish the replacement product until the old inventory is flushed from the supply chain. "This is going to cause some firms a lot of problems," notes Fleck in one of its reports, referring to it as an inventory visibility problem.

It's a particularly tricky balancing act for management, which must decide between virtually doubling its inventory by continuing to produce both leaded and lead-free parts and working off its leaded parts inventory as it transitions to lead-free products before the July 1, 2006 deadline for RoHS compliance. To ensure that exempt product users continue to meet their needs, iNEMI has formed the iNEMI High-Reliability Task Force. Comprising OEMs and contract manufacturers, the task force has been surveying the components supply base to see if it makes sense to organize an industry forum to bring together high-reliability users and suppliers for further discussion of these needs. The task force promotes the continued availability of tin-lead components.

Most companies don't want to be stuck with obsolete products. A survey in July by Technology Forecasters, conducted by the distributor Avnet, indicates that many industry companies anticipate having to scrap their excess inventory as a result of RoHS initiatives.

"We are going to exhaust it the best we can," said one survey interviewee. "We will use it some-

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where on a non-RoHS product, sell it at a secondary market, or we will throw it away." *(Check Chapter 7, "Industry & Government Web Sites & Contacts Of Interest," on this Web site for a list of product obsolescence specialists.)*

Some companies tracking the WEEE takeback directive ask if consumers will actively participate in the collection of electronics products by recyclers. Their attitude is that if small, medium-sized, and even some large suppliers aren't well informed on the regulations and issues, how will consumers respond?

The industry is already behind the curve on how suppliers should inform their OEMs on details of the materials of their components and their compliance status. This is forcing the IPC (Association Connecting Electronic Industries) to propose two standards that deal with generic and specific material declaration requirements. Both proposals are working their way through the industry. A final standard isn't expected to be published until the end of this year.

U.S. LEGISLATION

The industry also still has to contend with any legislation coming out of the U.S. Congress. At least three legislative proposals are working their way very slowly through Congress and, by EU standards, they're not very demanding. At the state level, only California, Maine, and Maryland have passed laws to handle and recycle electronic waste. Several other states and New York City have proposed bills that would, in their own way, control the flow of e-waste into regional landfills.

And there's the rub. Fearing their member companies might have to adopt their product designs to different laws from each state, the Consumer Electronics Association has been lobbying Congress to pass a single e-waste/recycling bill that the entire industry can live with.

Greenpeace International also is now involved in e-waste, recently publishing a report that says, based on its "scientific investigations," hazardous chemicals have been found in the scrap yards where e-waste is recycled in China and India. These chemicals, such as heavy metals, are being released into the workplace and the surrounding environment.

"The data reinforces the need for the electronics industry to eliminate the use of harmful substances in their products at the design stage and take responsibility for their products at the end of their life cycle," says Kevin Brigden, a Greenpeace International scientist who collected the samples.

Part of the problem is believed to result from working agreements between some U.S. and Chinese recyclers. Also, despite an EU ban on exports of hazardous materials including e-waste to developing countries, Brigden notes the increasing evidence of e-waste being sent to Asia from Europe illegally. But the majority of the waste exported to Asia actually comes from the U.S.

JUST THE BEGINNING

RoHS, WEEE, and other e-waste and recycling laws are just the beginning. Next comes eco-design, or designing products from scratch with the environment in mind. It's already law. With the EU's Eco-Design for Energy Using Products (or EuP) directive 2005/32/EC, the EU wants designers to consider the environment over the entire life of certain electronic products and home appliances, as well as their disposal. Several companies already design features into their products to facilitate the recycling process. Apple Computer says it uses highly recyclable materials such as polycarbonate. Apple also claims that many of its mechanical plastic parts use just one material. Several Japanese companies report they're studying the use of biodegradable materials in their product designs.

Although the EuP directive is already "in force," EU member states have almost two years—until August 11, 2007—to create national laws and regulations to comply with the EU's eco-design directive. The European Commission (EC) hopes to develop a publicly available eco-design plan by July 6, 2007 that will indicate the product groups it plans to bring under the scope of its EuP framework over the following three years. The plan is subject to annual revision. At the end of the three-year period (July 2010), the EC will review the directive's implementation and present any proposals for revision to the European Parliament.

The EC expects to introduce measures for specific products. As ambitious as the plan sounds, the EC hopes to minimize any harmful impact to companies, especially small- and medium-sized equipment manufacturers.

REACH OUT

Another directive, called Registration, Evaluation, and Authorization of Chemicals (REACH), eventually will require registration of chemicals made in or imported to the EU. Already, it has incurred the wrath of Orgalime, a European trade group that supports EU-based engineering companies. Orgalime wants REACH harmonized at a global level to guarantee a level playing field for the industry, which operates globally.

The EU is expected to act on REACH by 2006. Japanese OEMs, anticipating regulations covering the removal of additional toxic and other substances from their products, have already sent their component suppliers questionnaires asking them to list every chemical in their devices.

Neither the EuP nor REACH has unanimous industry support in Europe, though. Orgalime has also been critical of the EU's EuP legislation, including very specific provisions that call for the selection and use of raw materials, the use of substances classified as hazardous to health and/or the environment, and emissions into the air, water, and soil.

Another potential tempest beyond REACH is how OEMs, distribution centers, and retailers handle the recycling of shipping materials. The industry discards millions of tons of cardboard waste, shipping crates, and boxes annually. It's under discussion in the EU because it could increase costs.

As more portable devices come into use, battery makers also are under pressure to find new ways to squeeze more life out of their products. This will avoid more waste.

One more point of attack down the road is standby power, the electrical energy used simply by having an electronic product or appliance plugged into an electrical outlet. It consumes an estimated 15% of the energy used in a home. Industry companies are hearing from regulatory agencies about how they must respond to this form of e-waste. The California Energy Commission has adopted mandatory efficiency requirements for external power supplies and consumer audio and video equipment sold in California. Several foreign governments have passed or proposed similar directives.

CONVERSION COSTS

Shifting to environmental compliance won't come cheap. The industry has spent billions of dollars to convert to lead-free manufacturing, and billions more may be necessary to comply with future requirements. Despite statements to the contrary by many manufacturers, some of these costs eventually will be passed on to customers or consumers.

Aside from the cost of redesigning and developing new products and selling off or recycling older products, management also must deal with a whole raft of new-supply chain issues, from developing new manufacturing processes to working with customers and suppliers to develop conversion schedules. Virtually every key department of any industry company—design, manufacturing, logistics, test, IT, and purchasing, for starters—are involved in the RoHS/WEEE conversion process.

Any possible good news out of all this activity may come on the technical side. According to market analyst Frost & Sullivan, product differentiation—not only value-added products, but also in services—would bring this. F&S believes that lead-free and new electronic packaging designs could mean better performance semiconductors. The demand for technically superior but low-cost products also might fuel innovation. Going forward, F&S suggests that greater standardization of electronic packaging technologies, the push for greater device miniaturization, and the rise in demand for consumer electronics will sustain end-user interest in next-generation back-end semiconductor manufacturing technologies.

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electronic design

RoHS: Industry And Government Contacts Of Interest

By Ron Schneiderman

Several organizations have issued guidelines, background information, standards data, information on obsolete parts, and other information on various aspects of the European Union's Restrictions on Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) directives. For additional information, visit the sites below:

GOVERNMENT AGENCIES
• The U.K.'s Department of Trade and Industry current RoHS guidlines are available at *www.dti.gov.uk/sustainability*, or *www.dti.uk/sustainability/pdfs/finalrohs.pdf*. Information on the EU's Waste from Electrical and Electronic Equipment (WEEE) directive can be located at *www.dti.gov.uk/sustainability/weee*.

• The International Electrotechnical Commission (IEC), found at *www.iec.ch*, prepares and publishes international standards. It has formed a technical committee to develop procedures for determining levels of regulated substances in electrotechnical products.

• U.S. Environmental Protection Agency: *www.epa.gov* and the Hazardous Waste Resource Center: *www.etc.org*.

• California has enacted legislation that restricts the same substances as the EU's RoHS and operates on the same timeline. The state passed the Electronic Waste Recycling Act in 2003. Visit *www.leginfo.ca.gov*.

• Information on Massachusetts legislation that covers electronic waste: *www.mass.gov/legis*.

• Japan Ministry of Economic, Trade & Industry: *www.meti.go.jp;* For information on Japan's 3R Policies (Reduce, Reuse, Recycle), go to 3r-info@meti.go.jp.

TRADE ASSOCIATIONS
• The Electronic Industries Alliance (EIA) has drafted a standard for a material composition declaration guide: *www.eia.org/resources/2003-09-19.10pdf*.

• The European Industry Association's EICTA represents Europe's information, communications technology, and consumer electronics industries, and it participates in the development and implementation of EU policies: *www.eicta.org*.

• Orgalime (European Mechanical, Electroncal, Electronic, Metalworking Industries), a Brussels-

based electronics trade group: *www.orgalime.org*.

• JEDEC Solid State Technology Association: *www.jedec.org*.

• The American Electronics Association (AeA) has a site on international environmental policies and initiatives, at *www.aeanet.org*, or *www.aeanet.org/governmentaffairs/gajg_intienviro_overview.asp*.

• Bromine Science and Environment Forum: *www.bsef.com* and *www.ebfrip.com*.

• Intellect (IT and Consumer Electronics Trade Body): *www.intellectuk.org*.

• The International Association of Electronic Recyclers (IAER) projects that the enormous volume of end-of-life electronics from all industry sectors will require its members to grow their capacity by a factor of four or five by the end of this decade: *www.IAER.org*.

• The International Electronics Manufacturing Initiative's (iNEMI) lead-free assembly project has tested various solders and recommended a specified lead-free solder: *www.inemi.org/cms*.

• Japan Electronics and Information Technology Industries Association: *www.jeita.org.jp/english/index.htm*.

• The Association Connecting Electronics Industries (IPC) has worked with the U.S. Environmental Protection Agency (EPA) to find an alternative, lead-free surface finish for printed wiring boards: *www.epa.gov* and *www.leadfree.ipc.org*.

• The High-Density Packaging Group (HDPUG) has published a free reference guide for companies wanting to implement a lead-free board manufacturing process: *www.hdpug.org*.

• Institute of Interconnecting and Packaging Electronic Circuits (IPC) Lead Free: *www.leadfree.org*. Product marking guidelines have been established by the IPC (IPC-1066). These guidelines require products to be marked with the lead-free (Pb) symbol to the left.

• The National Electronic Distributors Association (NEDA) has been holding regular conferences on nontechnical supply-chain issues and opportunities related to RoHS regulations. It has published the Distributors' Position Paper On Lead Free Product Transition And RoHS Compliance: *www.nedassoc.org*.

• Consumer Electronics Association: *www.ce.org*.

• ASTM International provides a management system for the development of standards and relation information for materials, products, systems, and services used globally. All segments of the industry participate in their development of this information: *www.astm.org*.

• The Semiconductor Industry Association's Environment Committee has focused on chemical issues global and has provided input to the EU on RoHS-related issues: *www.sia-online.org*.

• The Fabless Semiconductor Association is the global voice of fabless and hybrid semiconductor companies and their foundry and supply-chain partners. Fabless revenue represented 16.6% of total semiconductor industry sales in 2003: *www.fsa.org*.

• Associaton of German Electrical Manufacturers (ZVEI): *www.zvei.org*.

• National Center for Manufacturing Sciences: *www.ncms.org*.

• Industry Council for Electronic Equipment Recycling (ICER): *www.icr.org.uk/index.htm*.

• The SMART Group promotes education and training in surface-mount and related technologies: *www.smartgroup.org/default.asp*.

• Tin Technology is a member-based group specializing in tin technology: *www.tintechnology.biz*.

• IEEE Components, Packaging, and Manufacturing Technology Society (CPMT) Technical Committee on Green Electronics, Manufacturing & Packaging: *www.cpmt.org/tc/gemp/index.html*.

• IEEE Computer Society Technical Committee on Electronics & the Environment: *www.tab.computer.org/ehsc*.

• Surface Mount Technology Association: *www.smta.org*.

• Japan Electronics & Information Technology Industries Association (JEITA): *www.jeita.or.jp/english/public/index.htm*.

• ASTM International provides a forum for development of voluntary standards and has formed a committee to develop standards for evaluating materials and products for RoHS compliance. Its Web site can be found at *www.astm.org*.

INDEPENDENT SOURCES

• Greenpeace: *www.greenpeace.org.uk/Products/Toxics/chemicalhouse.cfm*.

• Hewlett-Packard: *www.hp.com/environment*.

• Samsung: *www.samsung-europe.com/environment/redirectuk.htm*.

• The Computer-Aided Life Cycle Engineering (CALCE) Electronic Products & Systems Center, a University of Maryland-based consortium, is dedicated to providing a knowledge and resource base to support the development of competitive electronic components and systems. CALCE has initiated a reliability study of Pb-free assemblies to examine issues related to PWB surface and component terminal finish, the durability of package-to-board interconnects under temperature cycling, and vibration. CALCE also has conducted surveys of electronic part suppliers. For its members, it published *Lead-Free Electronics*, a reference book on Pb-free electronics. To learn more, visit *www.calce.umd.edu/lead-free/*.

• Underwriters Laboratories (UL) has developed a program to assist companies in complying with the European Union's RoHS directive for electronics. The UL RSCS Program tests and monitors substances targeted by the RoHS directive, and it will help companies self-declare compliance with the directive. The program also offers companies a password-protected database to help them manage restricted substances test data. The database comprises specific manufacturer-supplied parts numbers and corresponding test data. Visit *www.uluniversity.com*.

• AIM is a manufacturer of assembly materials for the electronics industry: *www.solder.com*.

• Arrow Electronics: *www.arrow.com/aws/leadfree_research*.

• Avnet Electronic: *www.em.avnet.com*.

• Texas Instruments customers can enter a TI part number or cutomer-specific part number on its Web site, *www.ti.com/productcontent*, if it has been registered with TI. The customers obtain the complete material content, current production status, moisture sensitivity level, qualified reflow temperature, terminal finish, and current status of Pb-free or Green.

• Dionics is a U.K.-based distributor: *www.pb-free.info*.

• Raymond Communications is a seminar sponsor and publisher of international and state recycling laws and updates on global industry environmental developments: *www.raymond.com*.

• ERG Inc. is a consulting firm working on the EPA's Plug-In To eCycling program: *www.erg.com*.

• APSCO International is an Ohio-based EMS provider: *www.apsco.com/rohs*.

• Environmental Packaging International: *www.enviropac.com*.

• Ageus Solutions: *www.ageussolutions.com*.

• WeRecycle: *www.werecycle.com*.

• Niton has developed a handheld analyzer for lead-free solder and components: *www.niton.com*.

• TrueCycle: *www.truecycle.com*.

• ERNI Electroapparate GmbH (ERNI) develops and manufactures connectors for backplane and pc-board applications: *www.erni.com/leadfree*.

• Electronics Product Stewardship Canada (EPSC) provides guidelines for recycling issues in Canada at *www.epsc.ca*.

• Technology Forecasters is a market research firm at *www.techforecasters.com*.

• Audit Ltd. is a consultancy that provides information services for companies preparing to comply with the European Union's emerging RoHS and WEEE directives at *www.weeeaudit.com*.

• Fleck Research provides market and technology information on connectors, cable assemblies, and interconnect products at *www.fleckresearch.com*.

• Newark InOne, a small-quantity distributor of components and test equipment, can be found online at *www.newarkinone.com/rohs*.

• Environmental Packaging International, global packaging consultants, has a site at *www.enviropac.com*.

• Samtec: *www.samtec.com/lead-free*.

PRODUCT OBSOLESCENCE SPECIALISTS

• Arena Solutions Inc. provides on-demand product lifecycle management (PLM) solutions: *www.arenasolutions.com*.

• PCNalert provides component obsolescence information for OEMs and contract and component manufacturers: *www.pcnalert.com*.

• American Electronic Resources is a product obsolescence specialist: *www.aeri.com*.

• 4-Star Electronics stocks components for more than 400 different manufacturers: *www.4starelectronics.com*.

• i2 Content & Data Services specializes in product obsolescence management for OEMs, contract manufacturers, and distributors: *www.i2content.com/obsolescence/index.html*.

• Marvol USA Corp. is an authorized distributor of original cellular parts and accessories of all major brands: *www.cellular-parts.com*.

• Semitronics Corp. provides hard-to-find and discontinued devices: *www.semtexinternational.com*.

• Texas Components specializes in obsolete semiconductors: *www.texas components.com/Product_Obs.htm* or *www.texascomponents.com/contact_us.htm*.

• Omnify Software provides product lifecycle management (PLM) software to help manufacturers manage material restrictions based on RoHS and WEEE directives at *www.omnifysoft.com*.