ROHS

The **Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment** 2002/95/EC commonly referred to as the **Restriction of Hazardous Substances Directive** or **RoHS**) was adopted in February 2003 by the European Union. The RoHS directive took effect on 1 July 2006, and is required to be enforced and become law in each member state. This directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. It is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE) 2002/96/EC which sets collection, recycling and recovery targets for electrical goods and is part of a legislative initiative to solve the problem of huge amounts of toxic e-waste. In speech, RoHS is often spelled out, or pronounced

Details

Each European Union member state will adopt its own enforcement and implementation policies using the directive as a guide.

RoHS is often referred to as the lead-free directive, but it restricts the use of the following six substances:

1. Lead
2. Mercury
3. Cadmium
4. Hexavalent chromium (Cr^{6+})
5. Polybrominated biphenyls (PBB)
6. Polybrominated diphenyl ether (PBDE)

PBB and PBDE are flame retardants used in several plastics.

The maximum permitted concentrations are 0.1% or 1000 ppm (except for cadmium, which is limited to 0.01% or 100 ppm) by weight of *homogeneous material*. This means that the limits do not apply to the weight of the finished product, or even to a component, but to any single substance that could (theoretically) be separated mechanically—for example, the sheath on a cable or the tinning on a component lead.

As an example, a radio comprises a case, screws, washers, a circuit board, speakers, etc. The screws, washers, and case may each be made of homogenous materials, but the other components comprise multiple sub-components of many different types of material. For instance, a circuit board comprises a bare PCB, ICs, resistors, capacitors, switches, etc. A switch comprises a case, a lever, a spring, contacts, pins, etc, each of which may be made of different materials. A contact might comprise a copper strip with a surface coating. A speaker comprises a permanent magnet, copper wire, paper, etc.

Everything that can be identified as a homogeneous material must meet the limit. So if it turns out that the case was made of plastic with 2,300 ppm (0.23%) PBB used as a flame retardant, then the entire radio would fail the requirements of the directive.

In an effort to close RoHS loopholes, in May 2006 the European Commission was asked to review two currently excluded product categories (monitoring and control equipment, and medical devices) for future inclusion in the products that must fall into RoHS compliance. In addition the commission entertains requests for deadline extensions or for exclusions by substance categories, substance location or weight.

Note that batteries are not included within the scope of RoHS. However, in Europe, batteries are under the European Commission's 1991 Battery Directive (91/157/EEC[1]), which was recently

increased in scope and approved in the form of the new battery directive, version 2003/0282 COD, which will be official when submitted to and published in the EU's Official Journal. While the first Battery Directive addressed possible trade barrier issues brought about by disparate European member states' implementation, the new directive more explicitly highlights improving and protecting the environment from the negative effects of the waste contained in batteries. It also contains a program for more ambitious recycling of industrial, automotive, and consumer batteries, gradually increasing the rate of manufacturer-provided collection sites to 45% by 2016. It also sets limits of 5 ppm mercury and 20 ppm cadmium to batteries except those used in medical, emergency, or portable power-tool devices. Though not setting quantitative limits on quantities of lead, lead-acid, nickel, and nickel-cadmium in batteries, it cites a need to restrict these substances and provide for recycling up to 75% of batteries with these substances. There are also provisions for marking the batteries with symbols in regard to metal content and recycling collection information.

The directive applies to equipment as defined by a section of the WEEE directive. The following numeric categories apply:

1. Large and small household appliances.
2. IT equipment.
3. Telecommunications equipment (although infrastructure equipment is exempt in some countries)
4. Consumer equipment.
5. Lighting equipment—including light bulbs.
6. Electronic and electrical tools.
7. Toys, leisure, and sports equipment.
8. Medical devices (currently exempt)
9. Monitoring and control instruments (currently exempt)
10. Automatic dispensers.

It does not apply to fixed industrial plant and tools. Compliance is the responsibility of the company that puts the product on the market, as defined in the Directive; components and sub-assemblies are not responsible for product compliance. Of course, given the fact that the regulation is applied at the homogeneous material level, data on substance concentrations needs to be transferred through the supply chain to the final producer. An IPC standard has recently been developed and published to facilitate this data exchange, IPC-1752. It is enabled through two PDF forms that are free to use.

RoHS applies to these products in the EU whether made within the EU or imported. Certain exemptions apply, and these are updated on occasion by the EU.

Product category 8 and 9 exclusions

Medical devices, and monitoring and control instruments comprise RoHS Category 8 and Category 9 products respectively. The EU recognizes that these products are manufactured in small numbers and generally have a long product life. Further, these products are often used in mission-critical applications where their failure can reasonably be expected to be extremely disruptive, if not catastrophic. Since the long term effects of lead-free solder, a primary RoHS objective cannot be known for a period of at least five years following the directive’s application to the remaining eight categories, the EU has established at least a temporary moratorium for Category 8 and 9 products.

In an effort to gain more insight the EU commissioned a study to assess when and if the RoHS directive should be applied to Category 8 and 9 products. Released in July 2006, the *Review of Directive 2002/95/EC (RoHS) Categories 8 and 9 – Final Report* recommended that Category 8 and 9 products remain exempt from the RoHS directive until 2012 or 2018 depending upon specific product sub-categories and applications. Since the EU has not yet adopted this

recommendation, the exact timing of RoHS application to Category 8 and 9 products remains uncertain.

Hazardous Materials and The High-Tech Trash Problem

RoHS and other efforts to reduce hazardous materials in electronics are motivated in part to address the global issue of consumer electronics waste. As newer technology arrives at an ever increasing rate, consumers are discarding their obsolete products sooner than ever. This waste ends up in landfills and in countries like China to be "recycled."

"*In the fashion-conscious mobile market, 98 million U.S. cell phones took their last call in 2005. All told, the EPA estimates that in the U.S. that year, between 1.5 and 1.9 million tons of computers, TVs, VCRs, monitors, cell phones, and other equipment were discarded. If all sources of electronic waste are tallied, it could total 50 million tons a year worldwide, according to the UN Environment Programme.*"

Recycling efforts may be doing more harm than good. Not only are adult and child workers in these jobs being poisoned by heavy metals, but these metals are returning to the U.S. "*The U.S. right now is shipping large quantities of leaded materials to China, and China is the world's major manufacturing center,*" Jeffrey Weidenhamer says, a chemist at Ashland University in Ohio. "*It's not all that surprising things are coming full circle and now we're getting contaminated products back.*"

Changing Toxicity Perceptions

In addition to the high-tech trash problem, RoHS reflects contemporary research over the past 50 years in biological toxicology that acknowledges the long-term effects of low-level chemical exposure on populations. New testing is capable of detecting much smaller concentrations of environmental toxins. Researchers are associating these exposures with neurological, developmental, and reproductive changes.

RoHS and other environmental laws are in contrast to historical and contemporary law that seek to address only acute toxicology, that is direct exposure to large amounts of toxins causing severe injury or death.

Life-cycle impact assessment of lead-free solder

The United States Environmental Protection Agency (EPA) has published a life-cycle assessment (LCA) of the environmental impacts of lead-free and tin-lead solder, as used in electronic products. For bar solders, when only lead-free solders were considered, the tin/copper alternative had the lowest (best) scores. For paste solders, bismuth/tin/silver had the lowest impact scores among the lead-free alternatives in every category except non-renewable resource consumption. For both paste and bar solders, all of the lead-free solder alternatives had a lower (better) LCA score in toxicity categories than tin/lead solder. This is primarily due to the toxicity of lead, and the amount of lead that leaches from printed wiring board assemblies, as determined by the leachability study conducted by the partnership. The study results are providing the industry with an objective analysis of the life-cycle environmental impacts of leading candidate alternative lead-free solders, allowing industry to consider environmental concerns along with the traditionally evaluated parameters of cost and performance. This assessment is also allowing industry to redirect efforts toward products and processes that reduce solders' environmental footprint, including energy consumption, releases of toxic chemicals, and potential risks to human health and the environment. Another life-cycle assessment by IKP, University of Stuttgart, shows similar results to those of the EPA study.

Life-cycle impact assessment of BFR-free plastics

The ban on concentrations of brominated flame retardants (BFR) above 0.1% in plastics has had an impact on plastics recycling. As more and more products include recycled plastics, it has become critical to know the BFR concentration in these plastics, either by tracing the origins of the recycled plastics to establish the BFR concentrations, or by measuring the BFR concentrations from samples. Plastics with high BFR concentrations are costly to handle or to discard, whereas plastics with levels below 0.1% have value as recyclable materials.

There are a number of analytical techniques for the rapid measurement of BFR concentrations. X-ray fluorescence spectroscopy can confirm the presence of bromine (Br), but it does not indicate the BFR concentration or specific molecule. Ion attachment mass spectrometry (IAMS) can be used to measure BFR concentrations in plastics. The BFR ban has had significant impacts both upstream — plastic material selection — and downstream — plastic material recycling.

Labeling

The WEEE directive logo

RoHS does not require any specific product labeling, however many manufacturers have adopted their own compliance marks to reduce confusion. Visual indicators in use today include explicit "RoHS compliant" labels, green leaves, check marks, and "PB-Free" markings. In addition, the closely related WEEE (Waste Electrical and Electronic Equipment Directive) trash-can logo with an "X" through it is an indicator that the product may be compliant. Chinese RoHS labels, a lower case "e" within a circle with arrows, can also designate compliance.

The proposed RoHS2 attempts to address this issue by requiring the CE mark, introducing an additional enforcement agency, Trading Standards.

ROHS in other regions

Please note that world wide standards and certification are available under the QC 080000 standard, governed by the NSAI (National Standards Authority of Ireland), to ensure the control of RoHs in industrial applications.

Asia / Pacific

China Order No. 39: Final Measures for the Administration of the Pollution Control and Electronic Information Products(often referred to as *China RoHS*) has the stated intent to establish similar restrictions, but in fact takes a very different approach. Unlike EU RoHS, where products in specified categories are included unless specifically excluded, there will be a list of included products, known as the *catalogue* — see Article 18 of the regulation — which will be a subset of the total scope of Electronic Information Products, or EIPs, to which the regulations apply. Initially, products that fall under the covered scope must provide markings and disclosure as to the presence of certain substances, while the substances themselves are not (yet) prohibited. There are some products that are EIPs, which are not in scope for EU RoHS, *e.g.* radar systems, semiconductor-manufacturing equipment, photomasks, etc. The list of EIPs is available in Chinese and English. The marking and disclosure aspects of the regulation were intended to take effect on July 1, 2006, but were postponed twice to March 1, 2007. There is no timeline for the catalogue yet.

Japan does not have any direct legislation dealing with the RoHS substances, but its recycling laws have spurred Japanese manufacturers to move to a lead-free process in accordance with

RoHS guidelines. A ministerial ordinance *Japanese industrial standard for Marking Of Specific Chemical Substances* (J-MOSS), effective from July 1, 2006, directs that some electronic products exceeding a specified amount of the nominated toxic substances must carry a warning label.

South Korea promulgated the *Act for Resource Recycling of Electrical and Electronic Equipment and Vehicles* on April 2, 2007. This regulation has aspects of RoHS, WEEE, and ELV.

Turkey announced the implementation of their Restriction of Hazardous Substances (RoHS) legislation effective June 2009.

North America

California has passed SB 20: Electronic Waste Recycling Act of 2003, or EWRA. This law prohibits the sale of electronic devices after January 1, 2007, that are prohibited from being sold under the EU RoHS directive, but across a much narrower scope that includes LCDs, CRTs, and the like and only covers the four heavy metals restricted by RoHS. EWRA also has a restricted material disclosure requirement.

Other US states and cities are debating whether to adopt similar laws, and there are several states that have mercury and PBDE bans already. Federal RoHS-like regulation in the US is unlikely in the near to medium term.