

Past and Present Uses of Lead in Consumer Electronics: A Status Report

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Short Biography for Tim McGrady

- Environmental Manager for LG Electronics' North American Operations
- Chairman of ASTM Committee F40 on Declarable Substances in Materials
- Former Auditor for Aerospace and Military (PRI – NADCAP)
- Former Principal Chemist and Lab Manager for a materials testing laboratory
- Former Product Development Chemist

Overview

- Regional Regulation of Lead in Consumer Electronics (CE)
- Non-Statutory Pressures to Eliminate Lead
- Where Lead Was Used in CE
- Where Lead May Still Be Used in CE
- “De Minimus” Concentration Limits
- Supply Chain Management
- Substitution
- Industry Concerns

Regional Regulation of Lead in CE

- European Union RoHS Directive 2002/95/EC
 - Implemented July 1, 2006
 - Limits lead (mercury, hexavalent chromium, PBBs, PBDEs) to 0.1% maximum (and cadmium 0.01% maximum) in each material
 - Covers approximately 100,000 products
 - Manufacturer (brand owner) responsible
 - Penalty if non-compliant products “put on the EU market”; determined via market surveillance
 - There are exemptions (see following slides)
 - Major impact on solder alloys (60/40 SnPb)
 - Manufacturers had to research, redesign and retool
 - CEA RoHS compliance cost analysis: \$38.25 billion

Regional Regulation of Lead in CE

EU RoHS Pb Exemptions

1. Lead in glass of cathode ray tubes, electronic components and fluorescent tubes
2. Lead as alloying element in steel (to 0.35%), aluminum (to 0.4%) and copper (to 4%)
3. Lead in high melting temperature type solders (Pb>85%)
4. Lead in solders for servers, storage and storage array systems (until 2010)
5. Lead in solders for network infrastructure equipment for switching, signaling, transmission as well as network management for telecommunications
6. Lead in electronic ceramic parts
7. Lead in lead-bronze bearing shells and bushes
8. Lead in compliant pin connector systems
9. Lead as a coating material for thermal conduction module ring
10. Lead in optical and filter glass
11. Lead in solders consisting of more than 2 elements for connection between pins and package of microprocessors, with a lead content >80%<85%
12. Lead in solders for connection between semiconductor die and carrier within integrated circuit flip chip packages
13. Lead in linear incandescent lamps with silicate coatings
14. Lead halide as radiant agent in HID lamps used in professional reprography applications
15. Lead as activator in fluorescent powder phosphors of discharge lamps used for sun tanning, reprography, lithography, insect traps; phosphors BSP, SMS
16. Lead with PbBiSn-Hg, PbInSn-Hg and PbSn-Hg amalgams in very compact Energy Saving Lamps
17. Lead oxide in glass used in bonding front and rear substrates of flat fluorescent lamps used for LCDs
18. Lead bound in crystal glass as defined in Annex I (categories 1,2,3 and 4) of Directive 69/493/EEC
19. Lead in printing inks for the application of enamels to borosilicate glass
20. Lead as an impurity in RIG (rare earth iron garnet) Faraday rotators used for fibre optic communication systems

Regional Regulation of Lead in CE

EU RoHS Pb Exemptions

- 21. Lead in finishes of fine pitch components other than connectors with a pitch of 0.65 mm or less with NiFe lead frames or copper lead frames
- 22. Lead in solders for soldering to machined through hole discoidal and planar array ceramic multilayer capacitors
- 23. Lead oxide in Plasma Display Panels (PDP) and surface conduction electron emitter displays (SED) used in structural elements; notably in the front and rear glass dielectric layers, the bus electrode, the black stripe, the address electrode, the barrier ribs, the seal frit and frit ring as well as in print pastes
- 24. Lead oxide in the glass envelope of Black Light Blue (BLB) lamps
- 25. Lead alloys as solder for transducers used in high powered loudspeakers (designated to operate at 125 dB SPL and above for several hours)

Notes:

- Exemptions are reviewed periodically and may be removed
- EU RoHS currently under review
- Lead may or may not be used in exempt applications
- Electronics industry has for the most part standardized products on EU RoHS requirements – wholesale changes to all products regardless of where sold
- **BUT** ... there are numerous other legislative efforts to restrict lead use in CE in other countries and in US States

The EU RoHS Directive and its amendments may be found at:
http://ec.europa.eu/environment/waste/weee/legis_en.htm

- China “RoHS”
- Korea “RoHS”
- Japan J-MOSS
- California “RoHS”
- California Proposition 65
- U.S. State Laws on Lead in Children’s Products
- U.S. State E-Waste Laws w/RoHS-like provisions
- FHSA, 15 U.S.C. 1261

Non-Statutory Pressures to Eliminate Lead

- Green Procurement
 - Example: EPEAT and Executive Order 13423
- Environmental NGOs
 - Example: Greenpeace Guide to Greener Electronics
- Internal Policies
 - Public Commitments
 - Life Cycle Analysis
 - Material and Product Specifications
- Media and Public Opinion
 - Brand Image
- Market Competition
 - Green marketing
- Green Financial Funds, Indexes
 - Examples: Green Century Fund, Dow Jones Sustainability Index

Where Lead Was Used in CE

- Solder Alloys for Component Mounting on Printed Wiring Boards
 - Internal circuitry
- Stabilizer in PVC
 - Wire and power cord casings (sheathing)
- Pigments in Plastics
 - Lead oxide, red & yellow lead chromate
 - Any colored plastic part; typically yellow, red or orange

To a large degree, these uses of Pb were eliminated by 2006 by most manufacturers; note 0.1% by weight limit for Pb except where more stringent regulations exist

Where Lead May Still Be Used in CE

- Isolated applications covered by EU RoHS
 - Where not prohibited by law
 - Where supply chain and market surveillance fail to catch violations
 - Most likely in small volume, limited-market, specialized and non-major brand products
- Applications exempted by EU RoHS
 - Any application – up to 0.1% by weight Pb
 - Machined Metal Parts
 - Screws, nuts, bolts – anything threaded or machined and made of steel, copper or aluminum
 - Cathode Ray Tube (CRT) TVs/Monitors
 - But CRT TVs and monitors are rapidly losing market share
 - Certain electronic components
 - See exemption list – most likely lead found in those parts

“De Minimus” Limits

- aka: Maximum Concentration Values (MCV)
- EU RoHS: 0.1% Pb Maximum in each material, unless exempt
- “Zero” as a limit is vague, indeterminate
 - Cannot count and characterize every atom or molecule within a product or material
- Limits must be within measurable range
 - Enforceable = measurable
 - If limit is set too low, measurement is more difficult and expensive; leads to problems with enforcement and compliance
- Exposure or migration limits problematic
- Carefully consider object of regulatory limits
 - Applying limits to whole products creates measurement and enforcement difficulties
 - Limiting individual materials is a better solution
- Industry desires regulatory harmony

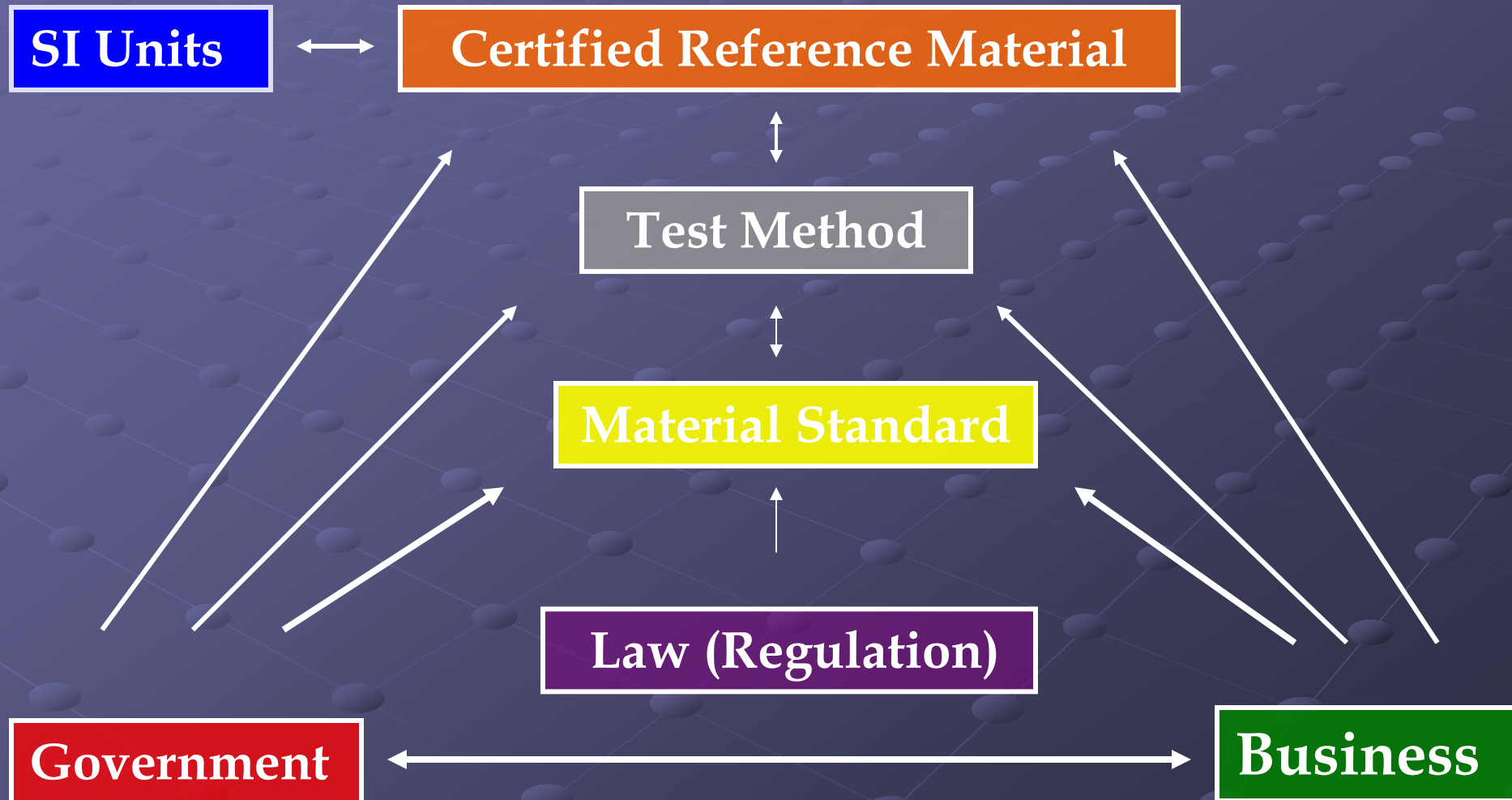
Supply Chain Management

- Starts with company policy
- Passed to company's quality function
- Communication with suppliers
- Suppliers (and their vendors) take action to comply
- Suppliers need to demonstrate compliance
- Suppliers qualified by company
- Companies and suppliers maintain surveillance as part of quality functions
- Market surveillance by third party can be measure of success or failure of system (feedback)

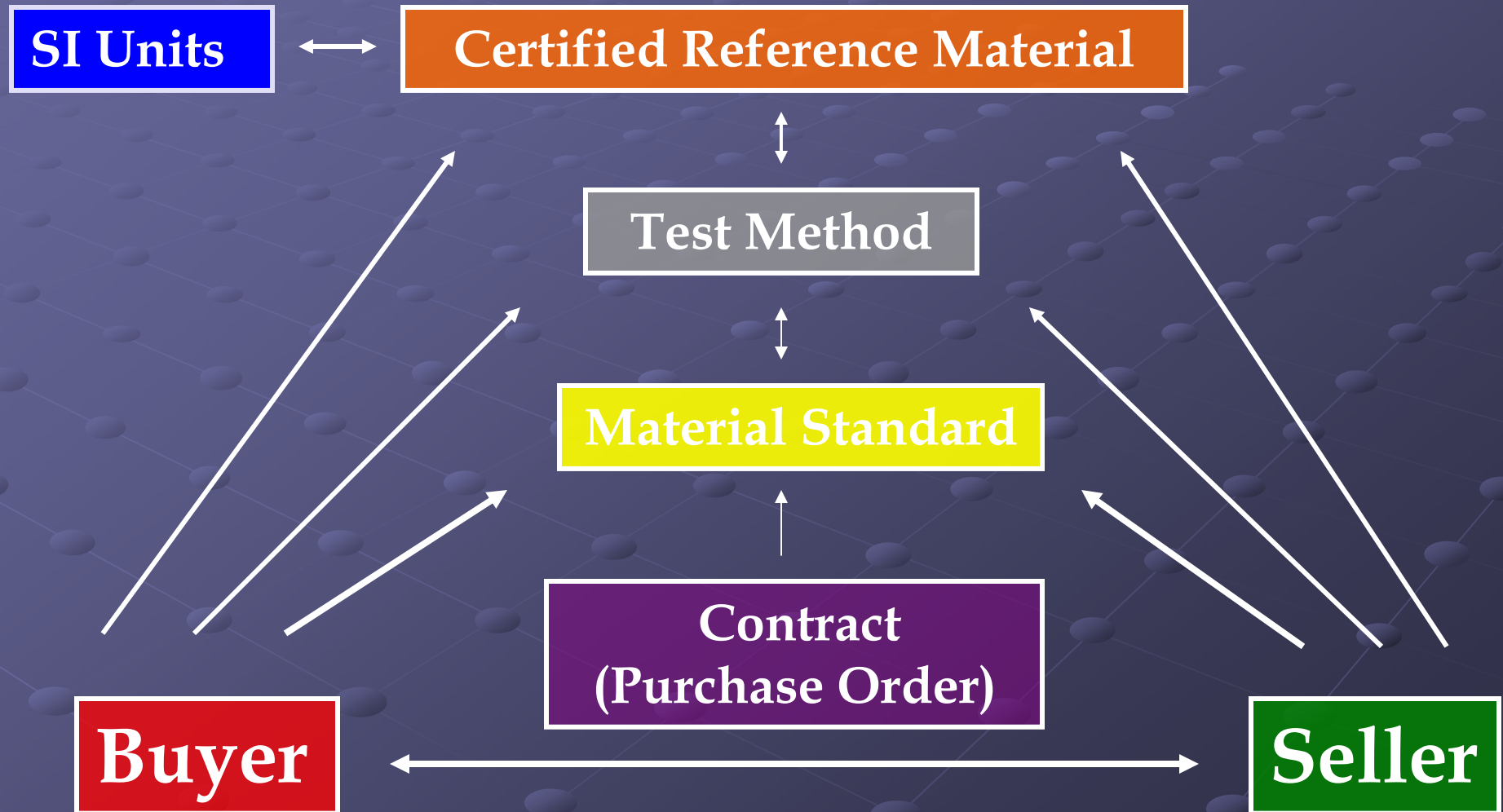
Supply Chain Management

- To assure successful supply chain management, companies/authorities must be vigilant to avoid:
 - Over-dependence on documentation
 - Lack or absence of measurement and standards
 - Substitution by third party
 - Falsification
 - Lack of oversight (e.g.: auditing & surveillance)
 - Lack of resources
 - Inadequate system to prevent non-conformances
 - Inadequate market surveillance
 - No consequences for non-conformance
 - Quality function reporting to production

Standards and Conformity Assessment Model



Standards and Conformity Assessment Model



Supply Chain Management

- Successful supply chain management does not have to be expensive
- In fact, it can be much less expensive than current systems
- Company Consortium(s)
 - Consolidation and harmonization of reporting
 - Share cost and task of system management
 - May use third party to administrate system
- Suppliers
 - Can consolidate testing and documentation, reduce audits and costs
 - Large customer base is incentive to cooperate
- Governments
 - Can coordinate with consortium(s)
 - Cut costs
 - Consolidate number of contacts
 - Consolidate and harmonize documentation

Substitution

- In general, viability of substitute materials or substances has not been well established
- Example: substitute solder alloys may not be more “environmentally friendly”
- Reliability and liability issues remain
- Still, most companies are committed to substitution where feasible
 - Examples: Intel announced 45 nanometer (nm) high-k metal gate (Hi-k) processors are going 100 percent lead-free. Panasonic announced lead-free PDP panels. LG Electronics made public commitment to eliminate hazardous substances from products.

Industry Concerns

- Safety of products is paramount
- Realization of toxicity requires route of entry
 - Lead toxic if ingested
 - Small quantities of lead in electronics not accessible
- Harmonization to existing requirements
- Minimize testing to level required
 - Shared costs
- Standards required
 - Focus on materials