Engineering Specification - Compliance Requirements for the European Union Directive (and other jurisdictions) on the Restriction of the Use of Certain Hazardous Substances (RoHS) in Electrical and Electronic Equipment for IBM Products

Note: This specification allows the exemption “Lead in solders for servers, storage and storage array systems.”

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Contents

1.0 Scope 2
1.1 Objectives 2
1.2 Definitions 2
1.3 Application and Verification 3
1.4 Document Administration 3
2.0 Requirements 4
2.1 Substances Prohibited From Use 4
2.2 Exemptions 5
2.3 Lead (Pb) and Lead (Pb) Compounds 8
2.3.1 Acceptable Lead (Pb) - Free Finishes for Electronic Components 8
2.3.2 Printed Circuit Boards 9
2.3.3 Cables and Connectors 10
2.3.4 Acceptable Uses of Leaded (Pb) Solder 10
2.3.5 Acceptable Non-lead(Pb) Solders for Paste, Wave and Rework Solder 10
2.4 Hexavalent Chromium (Cr^{+6}) and Hexavalent Chromium (Cr^{+6}) Compounds 10
2.4.1 Acceptable Substitutes for Metal Finishes 10
2.4.2 Base Materials 11
2.5 Cadmium (Cd) and Cadmium (Cd) compounds 12
2.6 PBBs and PBDEs 12
3.0 References 13
Appendix A. Revision History 14

1.0 Scope

1.1 Objectives

This Deliverable must comply with the European Union Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment, amendments, and with the requirements in this specification.

In order to comply with this Directive, this Deliverable must not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and/or polybrominated diphenyl ethers (PBDEs) in some cases above certain levels. See Sections 2.2, 2.3, and 2.4 for more specific information on exemptions and allowable substitute materials.

In addition to this specification, IBM maintains other environmental specifications for Deliverables, for example, IBM Engineering Specification 46G3772 - Baseline Environmental Requirements for Supplier Deliverables to IBM. See Section 3 for details and web site location. Where multiple documents exist which contain requirements for the same Deliverable, the most restrictive requirement applies.

1.2 Definitions

Deliverable(s) - any tangible item(s) delivered by or for a Supplier to IBM in accordance with a purchase contract or other agreement with IBM. Deliverables include, but are not limited to, components, Materials, Parts, Products and tools. See Section 1.3 for specific information about tools and consumable items.

Homogeneous Material - Means one material of uniform composition throughout or a material, consisting of a combination of materials that cannot be disjointed or separated into different materials by mechanical actions such as unscrewing, cutting, crushing, grinding and abrasive processes. For example, a plastic cover is a "Homogeneous Material" if it consists of one type of plastic that is not coated with or has attached to it or inside it any other kinds of materials. In this case, the limit values found in Table 1 would apply to the plastic. An electric cable that consists of

metal wires surrounded by nonmetallic insulation materials is an example of a "nonhomogeneous material" because the different materials could be separated by mechanical processes. In this case, the limit values found in Table 1 would apply to each of the separated materials. A semiconductor package contains many homogeneous materials which include plastic molding material, tin-electroplating coatings on the lead frame, the lead frame alloy and gold-bonding wires. Homogeneous is understood to be of uniform composition throughout.

Intentionally Added or Intentional Addition - a substance is deliberately utilized in the production of a Deliverable.

Materials - chemical substances and preparations that are supplied for the production of Parts, Products and other items (e.g., structural plastics, metals, coatings, paints, and adhesives) and chemical substances or preparations that are shipped with Parts or Products, such as toner, cleaners, lubricants, oils, and refrigerants.

Not Detected - below the detection limit of established test standards or appropriate industry wide test methods. In general, these test standards/ methods should achieve trace level detection or at the lowest detection capabilities of the specific sample matrix.

Parts - fabricated Materials, components, devices and assemblies.

Products - stand alone, final assemblies including complete machines supplied by an original equipment manufacturer (OEM).

RoHS - an acronym for the European Union (EU) Directive 2002/95/EC on the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment and subsequent amendments to this Directive and Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:174:0088:0110:EN:PDF.

1.3 Application and Verification

This engineering specification applies to all Deliverables supplied for IBM Server and Storage products, which have this specification cited on their respective IBM part number drawings, part or product specifications, procurement agreements, purchase contracts, purchase orders or other procurement documentation. The supplier is responsible for compliance with this specification as well as for any subcontracted operations and procured Parts, Materials, Products, or assemblies used in the manufacture of Deliverables for IBM Server and Storage applications. Upon request by IBM, the supplier will verify via analytical testing, compliance to this specification. Supplier may use analytical techniques to confirm results. Please refer to the document - IBM Systems and Technology Group (STG) RoHS Analysis Guideline SG-D-0417 located at:
Http://www-03.ibm.com/procurement/proweb.nsf/ContentDocsByTitle/United+States~Information+for+suppliers

This specification does not apply to consumable items such as ink cartridges, CDs, DVDs, floppy disks, tape cartridges, non-electrical tools (e.g., hammers, screwdrivers, ladders), customer instruction manuals or product packaging materials (e.g., cardboard and wood pallets). Electrical and electronic tools (with the exception of large-scale stationary industrial tools) are included within the scope of the EU RoHS Directive. RoHS compliance requirements for electrical and electronic tools for IBM products (e.g., electronic drills, electronic tools for welding, soldering, riveting, nailing or screwing) are addressed in specification 97P3864.

Deviation from the requirements of this specification must have prior written approval by IBM's procurement representative. IBM Procurement shall obtain the documented consent from the appropriate IBM representatives. IBM Procurement must contact the author of this document for details on the documentation requirements for deviations.

1.4 Document Administration

This document is maintained and controlled by IBM Systems and Technology Group.

2.0 Requirements

2.1 Substances Prohibited From Use

The EU RoHS Directive and legal requirements in other jurisdictions ban the use of the following in new electrical and electronic products:

- Lead (Pb),
- Mercury (Hg),
- Cadmium (Cd),
- Hexavalent chromium (Cr^{+6}),
- Polybrominated biphenyl (PBB) flame retardants, and
- Polybrominated diphenyl ether (PBDE) flame retardants.

This prohibition applies to the above substances and all compounds containing these substances. These substances and compounds must not be in or on any Deliverable except for the exemptions listed in Section 2.2 or in the allowed concentrations found in Table 1 below. The maximum allowable level found in a Homogeneous Material (e.g., metal, adhesive, paint, plastic, plating), cannot exceed the levels found in the table below. Please note these substances, generally in specific applications, have more restrictive requirements than those cited by the EU RoHS Directive. Please refer to IBM Engineering Specification 46G3772 for more restrictive requirements for all of the RoHS substances.

Table 1. EU RoHS Maximum Concentration Values(MCV)

Substance	RoHS Maximum Concentration Value in a Homogeneous Material- % by weight or (ppm)	Additional application restrictions may apply. See IBM specification 46G3772 for more details.
Lead (Pb)	0.1% or 1,000 ppm	Specific applications have more restrictive levels.
Mercury (Hg)	0.1% or 1,000 ppm	Any detectable level must be reported, except unavoidable impurities at levels below 10ppm.
Cadmium (Cd)	0.01% or 100ppm	Any detectable level must be reported for plating and surface coating applications.
Hexavalent chromium (Cr^{+6})	0.1% or 1,000 ppm	Specific applications have more restrictive levels.
Polybrominated biphenyl (PBB) flame retardants	0.1% or 1,000 ppm	Any detectable level must be reported.
Polybrominated diphenyl ether (PBDE) flame retardants. Note: IBM includes Decabromo diphenyl ether in this category	0.1% or 1,000 ppm	Any detectable level must be reported.

There are other jurisdictions, other than the EU Member States, with RoHS types of requirements. The list below is not complete and is provided for information only. In some jurisdictions the product scope and requirements are different from the scope and requirements of the EU Directive. Deliverables to IBM which cite this specification must meet the requirements of this specification irrespective of the jurisdiction where the Deliverable is transferred to IBM.

- Multiple US States
- New York City
- People's Republic of China
- European Free Trade Association Countries
- EU Candidate and Potential Candidate Countries – Croatia, Serbia, and Turkey
- Brazil
- Korea
- Ukraine

- Vietnam.

2.2 Exemptions

The following are the applications which are exempt from the requirements of RoHS as cited by the EU Directive, and subsequent amendments. The prohibition, as stated in Section 2.1, is in place for all other applications. IBM has determined some of the exemptions will not be allowed for IBM products. This information is noted by the exemption. Where specified by IBM in procurement documents, some of these exemptions may still be used when the order is for spare parts for the repair and reuse of equipment placed on the market prior to a specific date.

Table 2. RoHS Exemptions

No.	Expiration Date (if applicable)	Exemption
1		Mercury in single capped (compact) fluorescent lamps not exceeding (per burner): *
1(a)		For general lighting purposes < 30 Watts: 2.5 mg or less *
1(b)		For general lighting purposes ≥ 30 Watts and < 50 Watts: 3.5 mg or less *
1(c)		For general lighting purposes ≥50 Watts and < 150 W: 5 mg or less *
1(d)		For general lighting purposes ≥150 Watts: 15 mg or less *
1(e)		For general lighting purposes with circular or square structural shape and tube diameter ≤17 mm: 7 mg or less *
1(f)		For special purposes: 5 mg *
2(a)		Mercury in double-capped linear fluorescent lamps for general lighting purposes not exceeding (per lamp): *
2(a)(1)		Tri-band phosphor with normal lifetime and a tube diameter < 9mm (e.g., T2): 4 mg or less *
2(a)(2)		Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≤ 17 mm (e.g., T5): 3 mg or less *
2(a)(3)		Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g., T8): 3.5 mg or less *
2(a)(4)		Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g., T12): 3.5 mg or less *
2(a)(5)		Tri-band phosphor with long lifetime (> 25,000 h): 5 mg or less *
2(b)		Mercury in other fluorescent lamps not exceeding (per lamp): *
2(b)(1)	Expires on 13 April 2012	Linear halophosphate lamps with tube > 28 mm (e.g., T10 and T12): 10 mg or less *
2(b)(2)	Expires on 13 April 2016	Non-linear halophosphate lamps (all diameters): 15 mg or less. *
2(b)(3)		Non-linear tri-band phosphor lamps with tube diameter > 17 mm (e.g., T9): 15 mg or less *
2(b)(4)		Lamps for other general lighting and special purposes (e.g., induction lamps): 15 mg or less *
3		Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for special purposes not exceeding (per lamp): (Please note this is the exemption which should be used for CCFLs in liquid crystal displays (LCD). Exemptions 1, 2, and 4 should not be used for LCD CCFLs.)
3(a)		Mercury in CCFL and EEFL for special purposes not exceeding per lamp – Short lamp length (≤ 500 mm): 3.5 mg
3(b)		Mercury in CCFL and EEFL for special purposes not exceeding per lamp – Medium lamp length (> 500 mm and ≤1500 mm): 5 mg
3(c)		Mercury in CCFL and EEFL for special purposes not exceeding per lamp –Long lamp length (> 1500 mm): 13 mg
4(a)		Mercury in other low pressure discharge lamps (per lamp): 15 mg or less *
4(b)		Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner) in lamps with improved colour rendering index Ra > 60: *

No.	Expiration Date (if applicable)	Exemption
4(b)-I		P ≤ 155 W: 30 mg or less *
4(b)-II		155 W < P ≤ 405 W: 40 mg or less *
4(b)-III		P> 405 W: 40 mg or less *
4(c)		Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner): *
4(c)-I		P ≤ 155 W: 25 mg or less *
4(c)-II		155 W < P ≤ 405 W: 30 mg or less *
4(c)-III		P> 405 W: 40 mg or less *
4(d)	Expires on 13 April 2015	Mercury in High Pressure Mercury (vapour) lamps (HPMV) *
4(e)		Mercury in metal halide lamps (MH) *
4(f)		Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex *
5(a)		Lead (Pb) in the glass of cathode ray tubes
5(b)		Lead (Pb) in glass of fluorescent tubes not exceeding 0.2% by weight
6(a)		Lead (Pb) as an alloying element in steel for machining purposes and in galvanized steel containing up to 0.35% lead by weight
6(b)		Lead (Pb) as an alloying element in aluminum containing up to 0.4% lead by weight
6(c)		Copper alloy containing up to 4% lead by weight
7(a)		Lead (Pb) in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead)
7(b)	Please note IBM has a strategic plan to eliminate the use of this exemption in all Deliverables by July 1, 2014.	Lead (Pb) in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission, and network management for telecommunications
7(c)-I		Electrical and electronic components containing lead (Pb) in a glass or ceramic other than dielectric ceramic in capacitors, e.g., piezoelectronic devices, or in a glass or ceramic matrix compound
7(c)-II		Lead (Pb) in dielectric ceramic in capacitors for a rated voltage of 125V AC or 250V DC or higher
7(c)-III	**Expires on 1 January 2013** and after that date may be used in spare parts for EEE placed on the market before 1 Jan 2013. **This exemption is not allowed for new part numbers released after January 1, 2012**.	Lead in dielectric ceramic in capacitors for a rated voltage of less than 125V AC or 250V DC
7(c)-IV		Lead (Pb) in PZT based dielectric ceramic materials for capacitors being part of integrated circuits or discrete semiconductors
8(a)	This exemption is not allowed for IBM Deliverables	Cadmium and its compounds in one shot pellet type thermal cut-offs
8(b)		Cadmium and its compounds in electrical contacts
9		Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75 % weight in the cooling solution
9(a)	This exemption is not allowed IBM Deliverables	DecaBDE in polymeric applications (expired 30 June 2008)
9(b)		Lead (Pb) in bearing shells and bushes for refrigerant-containing compressors for heating, ventilation, air conditioning and refrigeration (HVACR) applications

No.	Expiration Date (if applicable)	Exemption
11(a)	This exemption is not allowed for IBM Deliverables	Lead (Pb) used in C-press compliant pin connector systems (exemption expired)
11(b)	**Expires on 1 January 2013** and after that date may be used in spare parts for EEE placed on the market before Jan 1, 2013. **This exemption is not allowed for new part numbers released after January 1, 2012.**	Lead (Pb) used in other than C-press compliant pin connector systems
12	This exemption is not allowed for IBM Deliverables	Lead (Pb) as a coating material for the thermal conduction module C-ring (exemption expired)
13(a)		Lead (Pb) in white glasses used for optical applications
13(b)		Cadmium and lead (Pb) in filter glasses and glasses used for reflectance standards
14	This exemption is not allowed for IBM Deliverables	Lead (Pb) in solders consisting of more than two elements for the connection between the pins and the package of microprocessors with a lead content of more than 80% and less than 85% by weight (expired 1 January 2011)
15	Please note IBM has a strategic plan to eliminate the use of this exemption in all Deliverables by July 1, 2014.	Lead (Pb) in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages
16	This exemption is not allowed for IBM Deliverables	Lead (Pb) in linear incandescent lamps with silicate coated tubes
17		Lead (Pb) halide as radiant agent in High Intensity Discharge (HID) lamps used for professional reprography applications
18(a)	This exemption is not allowed for IBM Deliverables	Lead as activator in the fluorescent powder (1% lead by weight or less) of discharge lamps when used as specialty lamps for diazoprinting reprography, lithography, insect traps, photochemical and curing processes containing phosphors such as SMS ($(Sr,Ba)_2MgSi_2O_7$:Pb) (expired 1 January 2011)
18(b)		Lead as activator in the fluorescent powder (1% lead by weight or less) of discharge lamps when used as sun tanning lamps containing phosphors such as BSP ($BaSi_2O_5$:Pb)
19	This exemption is not allowed for IBM Deliverables	Lead (Pb) with PbBiSn-Hg and PbInSn-Hg in specific compositions as main amalgam and with PbSn-Hg as auxiliary amalgam in very compact Energy Saving Lamps (ESL) (expired 1 June 2011)
20	This exemption is not allowed for IBM Deliverable	Lead (Pb) oxide in glass used for bonding front and rear substrates of flat fluorescent lamps used for Liquid Crystal Displays (LCDs) (expired 1 June 2011)
21		Lead (Pb) and Cadmium (Cd) in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses
22	This exemption is not allowed for IBM Deliverables	Lead (Pb) as impurity in RIG (rare earth iron garnet) Faraday rotators used for fibre optic communications systems (exemption expired)
23	This exemption is not allowed for IBM Deliverables	Lead (Pb) in finishes of fine pitch components other than connectors with a pitch of 0.65 mm and less (exemption expired)
24		Lead (Pb) in solders for the soldering to machined through hole discoidal and planar array ceramic multilayer capacitors
25		Lead (Pb) oxide in surface conduction electron emitter displays (SED) used in structural elements, notably in the seal frit and frit ring
26	This exemption is not	Lead (Pb) oxide in the glass envelope of black light blue lamps (expired 1 June 2011)

No.	Expiration Date (if applicable)	Exemption
	allowed for IBM Deliverables	
27	This exemption is not allowed for IBM Deliverables	Lead (Pb) alloys as solder for transducers used in high-powered (designated to operate for several hours at acoustic power levels of 125 dB SPL and above) loudspeakers (expired on 24 September 2010)
28	This exemption is not allowed for IBM Deliverables	Exemption expired 1 July 2007
29		Lead (Pb) bound in crystal glass as defined in Annex I (Categories 1, 2, 3 and 4) of Council Directive 69/493/EEC
30		Cadmium alloys as electrical/mechanical solder joints to electrical conductors located directly on the voice coil in transducers used in high-powered loudspeakers with sound pressure levels of 100 dB (A) and more
31		Lead (Pb) in soldering materials in mercury free flat fluorescent lamps (which e.g. are used for liquid crystal displays, design or industrial lighting)
32		Lead (Pb) oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes
33		Lead (Pb) in solders for the soldering of thin copper wires of 100 μm diameter and less in power transformers
34		Lead (Pb) in cermet-based trimmer potentiometer elements
35	This exemption is not allowed for IBM Deliverables	Cadmium in photoresistors for optocouplers applied in professional audio equipment (exemption expired)
36	This exemption is not allowed for IBM Deliverables	Mercury used as a cathode sputtering inhibitor in DC plasma displays with a content up to 30 mg per display (expired on 1 July 2010)
37		Lead (Pb) in the plating layer of high voltage diodes on the basis of a zinc borate glass body
38		Cadmium and cadmium oxide in thick film pastes used on aluminum bonded beryllium oxide
39	Expires on 1 July 2014	Cadmium in colour converting II-VI LEDs (< 10 μg Cd per mm^2 of light-emitting area) for use in solid state illumination or display systems
40	Expires on 31 December 2013	Cadmium in photoresistors for analogue optocouplers applied in professional audio equipment

*Exemptions 1 and 2 which are expected not to be used in IT equipment have been altered in this table to reflect the future allowable amount of mercury**.**

Batteries are exempt from the EU RoHS Directive but have their own requirements for material restrictions in other EU Directives and legal requirements in other jurisdictions. See IBM Engineering Specification 46G3772 for material restrictions for batteries.

2.3 Lead (Pb) and Lead (Pb) Compounds

2.3.1 Acceptable Lead (Pb) - Free Finishes for Electronic Components

The table below lists finishes that are acceptable per this specification. Finishes not designated in the following table may be acceptable pending review and approval by IBM Development Engineering. Contact IBM Procurement Engineering for information about this review. Typical applications include, but are not limited to, lead-frames, heat sinks, and connectors. The minimum tin or tin alloy thickness is determined by the application.

Table 3. Acceptable Finishes for Electronic Components

Finish	Notes
Palladium-Nickel (PdNi) with gold (Au) flash	For connectors, gold (Au) flash is 5-10 microinches.
Palladium-Nickel (PdNi) without gold (Au) flash	For connectors, IBM approval is required if gold (Au) flash is omitted from the mating or termination areas.

Finish	Notes
Fused , dipped, or reflowed 100% Tin (Sn) or Tin (Sn) Alloys	Acceptable without additional mitigation. Alloying elements include silver (Ag), bismuth (Bi), copper (Cu), zinc (Zn), and nickel (Ni).
Tin over nickel underlay (Sn/Ni)	Connectors require 1.25 microns nickel (Ni) thickness. Non-connector applications require 1.0 micron minimum nickel (Ni) thickness. Nickel (Ni) films with less than 1.0 micron thickness require IBM Development Engineering approval. Both bright and matte tins are acceptable with Nickel (Ni) underlay.
Annealed Tin (Sn) (matte, bright, or alloyed) over copper (Cu) base metal	Annealing temperature must be greater than 120°C for one hour or more. Annealing must occur within two weeks after plating. Anneal is not required if lead/pin pitch is > 1mm. For connectors: no forming after annealing.
Tin (Sn) over Alloy 42 (Fe/Ni) base metal, with or without Copper (Cu) underlay	Annealing is not required.
Tin alloy: Tin-Bismuth (SnBi) Nominal Bismuth (Bi) concentration: 2 - 4%. Total Bismuth (Bi) range: 1 - 5%	All other Bismuth (Bi) contents require IBM approval. Acceptable over copper, nickel, and Alloy 42 (FeNi). For connectors, specific IBM approval required for Tin-bismuth (SnBi) usage.
Tin alloy: Tin-Silver (SnAg). Minimum Silver (Ag) concentration: 1%	All other silver (Ag) contents require IBM approval. Acceptable over copper, nickel, and Alloy 42 (FeNi).
Tin alloy Tin-Copper (SnCu) annealed over a copper (Cu) base metal and Tin-copper (SnCu) over Nickel (Ni) underlay	Tin-copper (SnCu) over Copper (not annealed), and Tin-copper (SnCu) over Alloy 42 (FeNi) are not unconditionally acceptable as a finish. Requires IBM Development Engineering approval.
Noble Metals: Gold (Au)	For connector applications there must be a nickel underlay. The gold (Au) thickness is determined by the application.
Noble Metals: Silver (Ag)	All silver (Ag) finishes require IBM Development Engineering approval.
Immersion Tin	Does not require additional mitigation. Has been approved for heat sinks. Requires approval based on test data.
Nickel (Ni)	Acceptable for non-soldered surfaces, generally very difficult to solder.

Solderable finishes which are conditionally acceptable, are listed in IBM Procurement Specification 873444.

2.3.2 Printed Circuit Boards

All PCB soldering to be eutectic tin-lead (SnPb) solder unless otherwise approved by IBM. Contact IBM Procurement Engineering for information on the processes for approval of alternative solders.

Except for the specific exemptions listed in Section 2.2, printed circuit boards must not contain lead (Pb) in amounts greater than those shown in Table 1, including printed circuit board finishes. The RoHS-compatible finishes listed in the table below must also pass further IBM standard qualifications outside the scope of this specification. IBM-designed cards using the finishes listed below require approval from IBM Printed Circuit Board (PCB) Procurement Engineering.

Table 4. RoHS-Compatible Surface Finish Materials for Printed Circuit Boards

Finish	Notes
Immersion Tin	Requires approval from IBM PCB Procurement Engineering.
Organic Solderability Preservatives (OSPs)	Preferred, for example benzotriazole (BTA). Refer to IBM Procurement Specification 53P4082 for guidelines in selecting the appropriate OSP.
HASL (Hot Air Solder Leveled) Tin or Tin Alloy	Requires approval from IBM PCB Procurement Engineering.
Immersion Silver	Requires approval from IBM PCB Procurement Engineering.
Electroless Nickel Immersion Gold	Requires approval from IBM PCB Procurement Engineering.
Electrolytic Nickel with noble metal over plate	Requires approval from IBM PCB Procurement Engineering.

2.3.3 Cables and Connectors

Cable assembly components (e.g., jacket material, over molding materials, housings, tapes, shrink tubing, latches, thumbscrews) will be free of lead (Pb) compounds such as lead-based stabilizers and pigments, except where concentrations in the homogeneous material are less than the maximum concentration values cited in Table 1 or have an applicable exemption as cited in Section 2.2.

2.3.4 Acceptable Uses of Leaded (Pb) Solder

The following are considered acceptable uses of lead (Pb) solder in Server and Storage Products at this time. This section is applicable for all Deliverables supplied for IBM Server and Storage products that have this specification cited on their respective IBM part number drawing or in their part specification, purchase contract or purchase order. Any variances from this list require IBM approval. Contact IBM Procurement Engineering for information on approval processes. Please note: these acceptable uses of leaded solders will not be allowed in future releases of this specification, except for the repair and reuse of eligible equipment put on the market prior to a specific date. The exemption for lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission and network management for telecommunications may possibly be phased out in 2014. It is IBM's strategy to phase out the use of this exemption prior to July 1, 2014. It is anticipated that a lead time of six to 24 months will be required to phase out the listed uses below.

- Light crimp and solder of connector terminals
- Solder of copper tape over premold prior to overmold (for shielding)
- Solder dip wires prior to soldering
- Solder dip buss bars prior to soldering
- Solder applied to specific printed circuit board pads or plated through holes during processes that result in the attachment of electrical or mechanical components to these specific sites on the printed circuit board
- Soldering of connectors, wires, and components to printed circuit boards (PCBs) in cable assemblies
- Splices (usually used to create a jumper to eliminate double/triple crimps or light crimp and solder situations)
- Soldering of wires directly to terminals
- Solder cup terminals
- Soldering of braid and drain wires for ground connections
- All solder bumps/balls and solder column technology must remain leaded (Pb) unless approved by IBM. Tin/lead (SnPb) balls containing 2% silver (Ag) are acceptable
- As a finish for all termination based components (e.g. Chip capacitors, chip resistors, QFN, DFN) where the entire termination is covered by solder during the reflow soldering process
- Solder/brazing of fins to heatsinks.

2.3.5 Acceptable Non-lead (Pb) Solders for Paste, Wave and Rework Solder

Use of non-lead (Pb) solders for paste, wave, rework, and assembly requires approval from IBM Procurement Engineering.

2.4 Hexavalent Chromium (Cr^{+6}) and Hexavalent Chromium (Cr^{+6}) Compounds

Hexavalent chromium and its compounds must not be used in finishing processes for sheet steel, aluminized, electroless nickel and die cast parts, fasteners and heatsinks. Hexavalent chromium and its compounds must not be used prior to painting or in other surface treatments for metal parts.

2.4.1 Acceptable Substitutes for Metal Finishes

Acceptable substitutes for hexavalent chromium finishes may include but are not limited to the list below. The following list cites finishes that are compliant to RoHS requirements. Other requirements such as aesthetics may be necessary for parts. The part print is the master document which cites the material code to be used.

- IBM Material Code 06-091D, E and F: Hot dip galvannealed steel sheet without chromate
- IBM Material Code 06-091H: Steel, galvanized, commercial quality, coating designation Z120/G30, hot dipped galvanized, minimum spangled, temper passed (extra smooth) with hexavalent chromium-free chemical treatment, not oiled
- IBM Material Codes 06-131C: Steel, low carbon, commercial quality, electrogalvanized with hexavalent chromium-free chemical treatment, class B (ASTM A591)
- IBM Material Codes 07-xxx: Steels, alloy
- IBM Material Code 41-020 - Nickel plating
- IBM Material Code 41-027: Nickel-phosphorous electroless plating; specify thickness and class: decorative (alphabetic) and heat-treat (numeric). Post-plating processes which may include hexavalent chromium compounds are not permitted. Note: After 12/01/04, all electroless nickel bath chemistries must not employ Lead (Pb) or Cadmium (Cd) compounds in their formulation
- IBM Material Code 41-091 Type 2A: Zinc plating, black, 5-10 micrometers zinc with Type 2 black chromate must be hexavalent chromium-free, 0.7 grams per square meter
- IBM Material Code 41-091 Type 3: Zinc plating, black, non-conductive black finish
- IBM Material Code 41-093: Zinc plating, includes supplementary yellow or clear chromate conversion coating as specified below:
  - Type 1A: 5 micrometers zinc minimum with yellow iridescent chromate conversion coating which must be hexavalent chromium-free
  - Type 2A: 5 micrometers zinc minimum with clear chromate conversion coating which must be hexavalent chromium-free
  - Type 3A: (for thread-forming fasteners) 5-8 micrometers nickel alloy, 5-8 micrometers zinc with yellow iridescent coating which must be hexavalent chromium-free
- IBM Material Code 41-217A: Hexavalent chromium-free chromate conversion coating: tan on aluminum alloys
- IBM Material Code 41-218A, Hexavalent chromium-free chromate conversion coating: clear on aluminum alloys
- IBM Material Code 41-219A, Hexavalent chromium- free conversion coating for magnesium alloys
- IBM Material Code 41-225A, Hexavalent chromium-free conversion coating: black on aluminum alloys, 0.45 grams per square meter
- Steel with electroplated chromium finishes must be reviewed and approved by the IBM Development organization responsible for this hardware application
- Anodization is considered to be a compliant process
- IBM Material Code 61-0956 Electro-coating process, Black.

IBM Material Code information can be found at: http://bomdetail.services.ibm.com/matcodes/matcodes.nsf
Multiple IBM Material Codes have cited a specific ASTM standard at the above web address. Certification to that standard is acceptable verification of compliance to this specification.

2.4.2 Base Materials

The following are considered to be compliant to this specification and RoHS as long as the lead (Pb) content does not exceed the maximum concentration value referenced in Table 1 - 0.1% by weight in a homogeneous material. There is an additional exemption for the lead (Pb) content in steel, aluminum and copper alloys referenced below, see Section 2.2 for maximum allowable lead (Pb) content in these alloys. Please note, future releases of this specification will eliminate the exemptions for lead (Pb) as an alloying element in steel and aluminum and in copper alloys as these exemptions are eliminated by the EU RoHS Directive. If a surface coating is specified, it must also be compliant with this specification and RoHS. Surface coatings include plating and surface treatments such as passivation of steel. Please note surface coatings are not required for every application of a base metal.

- 06-XXX: Carbon steels that are not RoHS compliant are marked as such in the IBM Materials Bulletin. Surface coatings must be specified and must be RoHS compliant also (see Section 2.4.1.)
- 07-XXX: Stainless steels

- 06-080 - Steel, aluminized, type 1 or 2: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-081A - Steel, aluminized, type 1, commercial quality, coating designation T1-40: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-081B - Steel, aluminized, type 1, commercial quality, coating designation T1-25: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-082A - Steel, aluminized, type 1, drawing quality, coating designation T1-25: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-082B - Steel, aluminized, type 1, drawing quality, coating designation T1-25: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-083A - Steel, aluminized, type 2, commercial quality, coating designation T2-100: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 06-083B - Steel, aluminized, type 2, commercial quality, coating designation T2-65: either oiled or RoHS compliant chemical treatment; shall not contain any hexavalent chromium (Cr^{+6}) in surface treatment
- 01-XXX: Aluminum and aluminum alloys. Surface coatings must be specified and compliant
- 03-XXX: Copper and copper alloys. Surface coatings must be specified and compliant
- 12- XXX: Magnesium and magnesium alloys. Surface coatings must be specified and compliant
- 15-510, 511 and 512: Titanium and titanium alloys. Surface coatings must be specified and compliant
- 14-100, 101, 102, 110, 120, and 130: Zinc die cast alloys.

2.5 Cadmium (Cd) and Cadmium (Cd) compounds

Cadmium and its compounds and alloys must not be used in processes for or on IBM Deliverables (except where concentrations on or in the Homogeneous Material are less than the maximum concentration values cited in Table 1.) Examples of prohibited uses include but are not limited to the following applications:

- Coloration pigments, for example in cable conductor insulation or cable jacket material
- Stabilizers, for example in polyvinyl chloride (PVC) cables.

2.6 PBBs and PBDEs

Polybrominated biphenyls and polybrominated diphenyl ethers must not be used in IBM Deliverables. Examples of prohibited uses include but are not limited to the following applications:

- Flame retardants in printed circuit boards, components, gasketing and plastic resin parts.

This ban applies to all 209 congeners of PBBs and all 209 congeners of PBDEs including, but not limited to the following:

Polybrominated Biphenyls (PBBs)	Chemical Abstracts Service (CAS) #
2-Bromobiphenyl	2052-07-05
3-Bromobiphenyl	2113-57-7
4-Bromobiphenyl	92-66-0
Decabromobiphenyl	13654-09-6
Dibromobiphenyl	92-86-4
Heptabromobiphenyl	35194-78-6
Hexabromobiphenyl	59080-40-9
Hexabromo-1,1-biphenyl	36355-01-8
Nonabromobiphenyl	27753-52-2
Octabromobiphenyl	61288-13-9
Pentabromobiphenyl	56307-79-0
Polybrominated Biphenyl	59536-65-1
Tetrabromobiphenyl	40088-45-7
Tribromobiphenyl	59080-34-1
Firemaster FF-1	67774-32-7

Polybrominated Diphenyl Ethers (PBDEs)	CAS #
Bromobiphenyl Ether	101-55-3
Decabromobiphenyl Ether	1163-19-5
Dibromobiphenyl Ether	2050-47-7
Heptabromobiphenyl Ether	68928-80-3
Hexabromobiphenyl Ether	36483-60-0
Nonabromobiphenyl Ether	63936-56-1
Octabromobiphenyl Ether	32536-52-0
Pentabromobiphenyl Ether	32534-81-9
Tetrabromobiphenyl Ether	40088-47-9
Tribromobiphenyl Ether	49690-94-0

3.0 References

California Electronic Waste Recycling Act of 2003. Http://www.ciwmb.ca.gov/Electronics/Act2003/

EU Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Official Journal of the European Union 13.2.2003 http://ec.europa.eu/environment/waste/weee/legis_en.htm

EU Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:174:0088:0110:EN:PDF

EU Commission Decision 2011/534/EU of 8 September 2011 amending for the purposes of adapting to technical progress, the Annex to Directive 2002/95/EC of the European Parliament and of the Council as regards exemptions for applications containing lead or cadmium http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:234:0044:0045:en:PDF

EU Commission Decision 2005/618/EC of 18 August 2005 amending Directive 2002/95/EC of the European Parliament and of the Council for the purpose of establishing the maximum concentration values for certain hazardous substances in electrical and electronic equipment. http://ec.europa.eu/environment/waste/weee/legis_en.htm

EU Commission Decision 2005/717/EC of 13 October 2005 amending for the purposes of adapting to the technical progress the Annex to Directive 2002/95/EC of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. http://ec.europa.eu/environment/waste/weee/legis_en.htm

EU Commission Decision 2005/747/EC of 21 October 2005 amending for the purposes of adapting to technical progress the Annex to Directive 2002/95/EC of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. http://ec.europa.eu/environment/waste/weee/legis_en.htm

EU Commission Decision 2010/571/EU of 24 September 2010 amending the Annex to Directive 2002/95/EC of the European Parliament and of the Council as regards exemptions for applications containing lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls or polybrominated diphenyl ethers http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:251:0028:0034:EN:PDF

EU Corrigendum to Commission Decision 2010/571/EU of 24 September 2010 amending the Annex to Directive 2002/95/EC of the European Parliament and of the Council as regards exemptions for applications containing lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls or polybrominated diphenyl ethers http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:254:0048:0048:EN:PDF

Nilsson, Nils H., Malmgren-Hansen, B, and Ivan Christensen. *Denmark Development and use of screening methods to determine chromium (IV) and brominated flame retardants in electrical and electronic equipment.* Environmental Project No. 1292 2009. http://www2.mst.dk/udgiv/publications/2009/978-87-7052-987-7/pdf/978-87-7052-988-4.pdf

IBM Engineering Specification 46G3772: Baseline Environmental Requirements for Materials, Parts, and Products for IBM Logo Hardware Products.
Http://www.ibm.com/ibm/environment/products/especs.shtml or
Http://www-03.ibm.com/procurement/proweb.nsf/ContentDocsByTitle/United+States~Information+for+suppliers

IBM Information for Suppliers web site:
Http://www-1.ibm.com/procurement/proweb.nsf/ContentDocsByTitle/United+States~Information+for+suppliers

IBM Material Codes Directory. Http://bomdetail.services.ibm.com/matcodes/matcodes.nsf

Louisiana Mercury Risk Reduction Act of 2006 http://www.legis.state.la.us/billdata/streamdocument.asp?did=399136

New Jersey Electronic Waste Recycling Act Http://www.njleg.state.nj.us/2006/Bills/PL07/347_.PDF

Norway Product Control Regulation Chapter 2. Restricted Substances and Preparations
http://www.sft.no/seksjonsartikkel____30217.aspx

Rhode Island Mercury Education and Reduction Act http://www.rilin.state.ri.us/Statutes/TITLE23/23-24.9/INDEX.HTM

Appendix A. Revision History

Date	EC Level	Changes
2011-11-1	EC N48383	Section 1.2 – Definition of homogeneous material altered to match new ROHS recast. Definition of RoHS amended to include reference to new RoHS recast. Section 2.1 – New jurisdictions added with RoHS requirements. Section 2.2 – Exemptions 7cIV and 40 added. Lower restrictions for mercury in exemptions 3a, 3b and 3c now effective. Exemption expiration dates added for 14, 18a, 19, 20, 26, 27, and 36.
2010-10-29	EC N22230	Section 1.1 – Reference to Oko-Institute study removed. Section 1.3 – Reference to a separate deviation process for OEM equipment removed. OEM equipment must now follow same process as IBM logo equipment. Section 2.1 - Additional RoHS jurisdictions added. Section 2.2 - Reference to Oko-Institute study removed. Table 2 – Updated to show exemption status for Commission Decision 2010/571/EU and Corrigenda. Appendix B – Deleted.
2009-05-4	EC L36753	Section 1.1. - information added to show this revision includes the 2009 exemptions. Section 1.2 - Definition for "Not Detected" edited. Section 2.1 - Other RoHS jurisdictions added and clarification that not all are cited and may have differing scope and requirements. Table 1 - Reportable level for mercury edited. Table 2 - Added to clearly define new 2009 RoHS exemption status and sunset the use of exemptions 8a, 11a, 12, 14, 22 and 23 for IBM products and parts released after May 4, 2009. Section 2.2 -Table 2 added to show altered exemptions for 2009 changes. Exemptions 30, 31 and 32 added. Section 2.3.4 - Edit made to clarify that leaded solder exemption for servers and storage products will expire. Section 2.4.3 - Section detailing information about the modular refrigeration unit was deleted. Appendix B - Added to show the 2009 exemptions changes as recommended by Öko-Institut.
2007-11-26	EC L35908	Section 1.1 - Paragraph added to clarify that most restrictive requirement applies. Section 1.2 - Definitions added for Deliverable, Intentionally Added or Intentional Addition, Materials, Not Detected, Parts, and Products. The Deliverable replaced the words "material", "part", "product", and "assembly" in multiple locations throughout the specification Section 1.3 - Specification deviation process changed. Table 1 - Additional material restrictions required by other laws than EU RoHS, which are more restrictive than EU RoHS are now referenced in Engineering Specification 46G3772. Section 2.1 - Additional entries added to the list of jurisdictions with RoHS type requirements. Section 2.2 - The exemption numbers were aligned with the numbers in the EU RoHS Directive and amendments. Exemption 10b was added. Listing of batteries in the exemption list removed and replaced with a paragraph describing the exemption for batteries. Table 3 - Updated the RoHS-Compatible Surface Finish Materials for Printed Circuit Boards. Section 2.6 - PBB Table updated with CAS numbers. Section 3 - Additional references added.
2006-10-31	EC H86911	Title - Expanded scope of regulations to additional jurisdictions. Section 1.3 - Added text referring suppliers may use analytical techniques to confirm results with a reference to the document - IBM STG RoHS Analysis Guideline SG-D-0417 with web location. Section 2.1 - Expanded scope of regulations to other jurisdictions Section 2.1 - Table 1. Removed reference to an IBM STG RoHS Analysis Guideline. Further clarification for cadmium applications including an exemption for use of cadmium in electrical contacts. Allowable level for cadmium use in pigment, dye and stabilizer applications was raised to 100ppm due to a change in the Denmark Cadmium decree. The levels for PBBs and PBDEs were

Date	EC Level	Changes
		changed to reflect the requirements in 46G3772 of no intentional addition. Section 2.2 - Additional exemptions were added. Section 2.3 - Table 3 deleted and a reference made to IBM Procurement Specification 873444 for conditionally acceptable finishes. Section 3.0 - Additional references cited.
2006-03-24	H87225	Section 1.2 - A sentence was added to the end of the first paragraph to clarify "homogenous". Added "Homogeneous is understood to be of uniform composition throughout." Section 1.3 - Information detailing that electrical and electronic tools are covered, but non electrical tools are not. Consumable items, such as ink cartridges, CDs, DVDs, floppy disks, tape cartridges, customer publications and product packaging are not included. Requirements for deviations from the specification were added. Table 1- A separate line was added for cadmium in plating and the line for cadmium used in relays and circuit breakers was eliminated. Plating was removed from the 75 ppm category and put into a category where cadmium is not allowed in plating or surface coating. A footnote was added to clarify California Prop 65 requirements for frequently handled cables such as mice cables. No intentional addition of lead carbonates and lead sulfates in paints was added to the first footnote. This last requirement mirrors the requirement in 46G3772. In footnote 2 and 4, the supplier is referred to the procurement web site for an IBM document which references IBM recommended testing methodologies for mercury and cadmium. Footnote 5 now clarifies that hexavalent chromium is not allowed "in the manufacturing process." Section 2.2 - the RoHS exemption "Cadmium and its compounds in electrical contacts and cadmium plating....." was eliminated due to more stringent laws in Switzerland, The Netherlands and Austria. Section 2.3 - Table 2 for acceptable finishes was broke out into two tables - one for "Acceptable materials for electronic components" and one table for "RoHS-Compatible Materials for Printed Circuit Boards." Table 3 has additional acceptable finishes for Tantalum Niobium and Niobium Oxide Capacitors, Actives, Crystal/Oscillators, Resistors/Resistor Networks and Magnetics. Section 2.3.4 - New "Acceptable uses of leaded solder" were added - 1. as a finish for termination based components, 2. solder/brazing of fins to heatsinks and 3. lead use in specific part numbers. Section 2.3.2 - Section was rewritten, and Table 4 was created and added to the document. Section 2.4 - The wording was updated and clarified. Hexavalent chromium is not to be used in finishing processes for sheet steel, etc. Section 2.6 - The number 209 was added as the number of congeners of PBBs and/or PBDEs. Section 3.0 - Three new references were added - the three new EU Commission Decisions for maximum concentration values, and additional exemptions such as lead use in compliant pin connector systems.

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