



# Apple Regulated Substances Specification

## 069-0135-K

## 1. Scope

It's Apple's mission to make sure that anyone who assembles, uses, or recycles an Apple product can do so safely. We have led the industry in removing many harmful substances from our product designs, and we go to great lengths to make sure that they stay that way. We are constantly designing our products to be better for the environment, better for the people who use them, and better for the people who make them.

This Regulated Substances Specification describes Apple's global restrictions on the use of certain chemical substances or materials in Apple's products, accessories, manufacturing processes, and packaging used for shipping products to Apple's end-customers. Restrictions are derived from international laws or directives, regulatory agency or eco-label requirements, and Apple policies. Apple's restrictions may go beyond regulatory requirements in order to protect human health and the environment.

This specification is not an exhaustive list of all chemicals of concern. Apple suppliers should take action to understand the human health and environmental impacts of all chemicals used in the manufacturing process and present in parts and materials supplied to Apple. Suppliers should take action to reduce or eliminate the use of chemicals of concern listed in this specification as a first step, as well as comply with all applicable regulations. Suppliers must certify compliance with this specification and provide required documentation (including required test data, Full Material Disclosure (FMD), and disclosure of reportable substances). Suppliers must notify Apple of any changes in formulation of materials or parts.

We hold our suppliers accountable by conducting factory audits and testing materials and components at certified laboratories for substances of high concern. Apple may verify supplier data and compliance to this specification utilizing our in-house laboratory.

**Effective Date:** This specification takes effect on September 1, 2018. Prior to this date, revision J of the Regulated Substances Specification is in effect.

**Questions:** Questions regarding the Apple Regulated Substances Specification should be directed to Apple at [environment@apple.com](mailto:environment@apple.com).

## 2. Definitions

**Apple Policy:** Apple restrictions that go beyond regulatory requirements, based on best industry practices or toxicological properties.

**CAS:** Chemical Abstracts Service registry numbers that identify unique substances.

**Elemental chlorine free (ECF):** Packaging material produced with pulp that has been bleached using a chlorine derivative such as chlorine dioxide (ClO<sub>2</sub>), but without the use of elemental chlorine (Cl).

**External Materials:** Materials that are accessible to a customer under reasonable or foreseeable use.

**Final assembly:** Manufacturing process involving assembly of a product that is then directly sold to Apple customers, retail stores, or distribution channels.

**Endocrine Disrupting Chemicals (EDCs):** Chemicals that can interfere with the endocrine (hormone) system to cause possible adverse effects in humans and wildlife.

**Full Material Disclosure (FMD):** Initiative that requires suppliers to provide the entire chemical composition of the parts and materials used in Apple products to ensure compliance to regulatory requirements, corporate initiatives, and to support assessment of the impact to human and environmental health. See Section 11 for details.

**Homogeneous material:** One material of uniform composition throughout or a material, consisting of a combination of materials, that cannot be disjointed, disaggregated, or separated into different materials by mechanical actions such as unscrewing, cutting, crushing, grinding, and abrasive processes. The definition is consistent with Directive 2011/65/EU on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS 2). Per this document, the following examples illustrate what is and is not a homogeneous material:

- A plastic cover is a homogeneous material if it consists of one type of plastic that is not coated with other materials, or has other materials attached to it.
- A cable that consists of metal wires surrounded by nonmetallic insulation materials isn't a homogeneous material because mechanical processes could separate the different materials. In this case, restrictions apply to each of the separated materials individually.
- A semiconductor package contains many homogeneous materials that include the mold compound, die attach adhesive, die coatings, bonding wires, lead frame, and lead frame platings. Restrictions apply to each individual homogeneous material.
- Printed circuit board laminated materials consist of glass cloth, resins, and copper foil that are each a homogeneous material. Restrictions apply to each individual homogeneous material.

**Intentionally added:** Substance deliberately used in the formulation of a material or component, where the presence of the substance in the final product provides a specific characteristic, appearance, or quality.

**Nanomaterials:** A natural, incidental, or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 percent or more of the particles in the number size distribution, one or more external dimensions are in the size range 1 nm–100 nm. In addition, fullerenes, graphene flakes, and single-wall carbon nanotubes with one or more external dimensions below 1 nm should be considered as nanomaterials.

**Non-use:** Substance must not be intentionally or unintentionally added and is not detected using current or specified analytical methods.

**Packaging:** Packaging materials used to enclose or protect Apple products during shipment to the end-customer. Packaging shipped to suppliers or OEMs (e.g., tape and reel, trays), and packaging materials used to encapsulate board-level electrical components such as integrated circuits are not included in this definition.

**Per- and Polyfluoroalkyl Substances (PFAS):** Substances that contain one or more perfluoroalkyl moieties,  $-C_nF_{2n+1}$ .

**Personal protective equipment (PPE):** Equipment for protecting workers from exposure to hazardous materials in the workplace specific to the job function.

**ppm:** Parts per million by weight of a substance; equivalent to 1 mg/kg or 0.0001 percent by weight.

**Processed chlorine free (PCF):** Packaging material produced with pulp from virgin and/or recycled content that has been bleached without any type of chlorine, or that has not been bleached at all. Recycled content may have originally been bleached with chlorine or chlorine derivatives.

**Test Report Mapping (TRM):** The form used to map test reports to declared materials. The TRM form is created in and exported from the FMD Portal and replaces the Material Content Declaration (MCD) form. The TRM form and mapped test reports are collected by Apple manufacturing partners to document compliance of the parts and materials used in Apple products. The information required to create a TRM form for Apple's manufacturing partners is the foundation of an FMD declaration required by Apple. These processes have been harmonized to eliminate duplicative work and align requirements across the Apple supply chain.

**Totally chlorine free (TCF):** Packaging material produced with pulp from virgin content that has been bleached without any type of chlorine, or that has not been bleached at all.

### 3. Restricted Substances in Products

Restrictions in Section 3 apply to all homogeneous materials used in Apple products, accessories, and packaging. Substances and their respective restrictions are listed in alphabetical order.

| Chemical   | CAS No.  | Threshold                                     | Scope   | Examples   | References   |
|--|--|---|---|--|--|
| Antimony Trioxide  | 1309-64-4  | 1000 ppm                                      | All materials   | Flame retardant  | Apple Policy   |
| Arsenic<br>Arsenic compounds   | 7440-38-2<br>Several   | 2 ppm   | Wood products   | Pallets  | REACH 1907/2006 and amendments   |
|  |  | 50 ppm  | All other materials except semiconductors (substrates and dopants) and metal alloys | LCD display glass, camera lens, trackpad glass, display cover glass, antifouling agent   | Apple Policy   |
|  |  | 1000 ppm                                      | Metals only   | Copper alloys  |  |
|  |  | Exempt  | Semiconductor substrates and dopants  | GaAs semiconductors  |  |
| Asbestos and compounds   | 1332-21-4<br>12001-28-4<br>12001-29-5<br>12172-73-5<br>77536-66-4<br>77536-67-5<br>77536-68-6<br>132207-32-0 | Non-use                                       | All materials   | Insulator, filler  | REACH 1907/2006 and amendments   |
| Azo dyes, Arylamines, Anilines   | Appendix A   | 30 ppm total content                          | All materials   | Dye or colorant for plastics, textiles, leather  | REACH 1907/2006 and amendments<br>Bedarfsgegenstände<br>Verordnung<br>GB 18401-2010, China<br>GB 20400-2006, China |
| Benzenamine, N-phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (BNST) | 68921-45-9   | Non-use                                       | All materials   | Antioxidant additive in lubricants   | Canadian Environmental Protection Act, 1999  |
| Beryllium<br>Beryllium compounds   | 7440-41-7<br>Several   | 1000 ppm                                      | All materials   | Metals and ceramic materials in connectors, stiffeners, AC inlets, springs, EMI finger/spring, transceivers, brackets, housing, buttons, speaker wire, beryllia ceramic, copper beryllium alloys | Apple Policy   |
|  |  | Exempt  | Products shipped before Sept 2014   |  |  |
| Bisphenol A  | 80-05-7  | Non-use                                       | Thermal paper   | Thermal paper  | Apple Policy   |
|  |  | Report detectable levels of unpolymerized BPA | All materials   | Adhesives, plastics, epoxy resin   | California Proposition 65<br>Apple Policy  |
|  |  | 1000 ppm                                      | All other materials, unless preapproved by Apple                                    | Adhesives, plastics, epoxy resin   | REACH 1907/2006 and amendments   |
| Bromine<br>Brominated compounds  | 7726-95-6<br>Several   | 900 ppm                                       | All materials   | Flame retardant, flux, solder paste  | Apple Policy   |
|  |  | 1500 ppm (Cl + Br)                            |   |  |  |

| Chemical   | CAS No.  | Threshold   | Scope                   | Examples   | References   |
|--|--|---|-------------------------|--|--|
| Cadmium<br>Cadmium compounds   | 7440-43-9<br>Several   | 20 ppm  | Battery cells and packs | Nickel cadmium battery   | 2013/56/EU<br>IEEE 1680  |
|  |  | 50 ppm  | All other materials     | Pigment stabilizer, copper alloys                              | 2011/65/EU<br>GB/T 26572<br>Taiwan BSMI RoHS   |
| Chlorinated Paraffins, Short and Medium Chain (SCCP and MCCP)                    | Appendix B   | 1000 ppm total content and Cl < 900 ppm   | All materials           | Paint, coating, sealant, flame retardant, textiles, lubricants | REACH 1907/2006 and its amendments<br>EPA, SNUR 2070-AJ73,<br>Dec. 2014<br>IEEE 1680<br>Apple Policy |
| Chlorine<br>Chlorinated compounds  | 7782-50-5<br>Several   | Non-use;<br>Must be Elemental Chlorine Free (ECF), Totally Chlorine Free (TCF) or Process Chlorine Free (PCF) | Fiber-based packaging   | Fiber-based packaging  | IEEE 1680.1-2018<br>UL 110<br>Apple Policy   |
|  |  | 900 ppm   | All materials           | Flame retardant, flux, solder paste                            | Apple Policy   |
|  |  | 1500 ppm (Cl + Br)  |                         |  |  |
| Dimethylfumarate (DMFu)  | 624-49-7   | 0.1 ppm   | All materials           | Biocide, desiccant pack  | 2010/153/EC  |
| Formaldehyde   | 50-00-0  | 300 ppm   | All materials           | Wood, adhesives, plastics, coatings                            | ChemVerbotsV<br>GB 18401-2003/2005, China<br>GB 20400-2006, China                                    |
| Halogenated Diphenyl Methanes  | 76253-60-6<br>81161-70-8<br>99688-47-8                               | 1000 ppm and Br / Cl < 900 ppm  | All materials           | Capacitor, transformer   | REACH 1907/2006 and amendments<br>Apple Policy   |
| Hexabromocyclododecane (HBCDD)   | 25637-99-4<br>3194-55-6<br>134237-50-6<br>134237-51-7<br>134237-52-8 | Non-use or 100 PPM  | All materials           | Flame retardant  | 2004/850/EU  |
| Heavy Metals (Cd + Cr (VI) + Hg + Pb)  | 7440-43-9<br>18540-29-9<br>7439-97-6<br>7439-92-1                    | 100 ppm combined total  | Packaging               | Packaging materials  | 94/62/EC   |
| Hexavalent Chromium (Cr(VI), Cr <sup>6+</sup> )<br>Hexavalent Chromium compounds | 18540-29-9<br>Several  | 500 ppm   | All materials           | Metal coating, pigment   | 2011/65/EU<br>GB/T 26572<br>Taiwan BSMI RoHS   |
| Lacey Act and EU Timber Regulation   | Not Applicable   | Non-use   | All materials           | Paper products, cardboard, pallets, leather                    | US Lacey Act (16 U.S.C. §§ 3371-3378)<br>EU Timber Regulation  |

| Chemical                     | CAS No.  | Threshold                                | Scope   | Examples  | References  |
|------------------------------|--|--|---|---|---|
| Lead<br>Lead compounds       | 7439-92-1<br>Several   | 40 ppm                                   | Battery cells and packs   | Lead-acid, Zn-Mn, alkaline batteries  | 2013/56/EU  |
|                              |  | 50 ppm                                   | Plastics, inks, surface coatings, displays (including housing, wiring, and printed circuit board) | Paints, cable jacketing and insulation  | IEEE 1680.1-2009<br>CPSIA, 2008   |
|                              |  | 1000 ppm                                 | All other materials except all exemptions in 2011/65/EU and its amendments                        | Solder, coatings, glass, steel, copper alloys, aluminum alloys                    | 2011/65/EU<br>GB/T 26572<br>Taiwan BSMI RoHS                              |
| Mercury<br>Mercury compounds | 7439-97-6<br>Several   | 5 ppm                                    | Battery cells and packs   | Mercury oxide, zinc-manganese, alkaline manganese batteries                       | 2013/56/EU  |
|                              |  | 1000 ppm<br>Not intentionally added      | All other materials   | CCFL lamps, switches, dyes  | 2011/65/EU<br>IEEE 1680<br>GB/T 26572<br>Taiwan BSMI RoHS                 |
| Methyl-phenol compounds      | 95-48-7<br>106-44-5<br>108-39-4<br>1319-77-3                   | 10 ppm total content                     | All materials   | Cleaning compound, adhesives, resin, coatings                                     | Canadian Environmental Protection Act, 1999                               |
| Nickel and its compounds     | 7440-02-0<br>Several   | 0.28 µg/cm <sup>2</sup> /week leach rate | Parts with direct and prolonged skin contact  | Metal alloys with nickel, plating material, anti-corrosive alloy                  | REACH 1907/2006 and amendments  |
| Organotin compounds          | Appendix C   | 1000 ppm total content                   | All materials   | Glass coatings, antifouling coatings, silicones, polyurethanes, paints, adhesives | REACH 1907/2006 and amendments<br>Apple Policy                            |
| Perchlorates                 | 7601-89-0<br>7778-74-7<br>7790-98-9<br>7791-03-9<br>10034-81-8 | 0.1 ppm total content                    | All materials   | Lithium perchlorate coin cell batteries   | CA DTSC<br>Perchlorate Contamination Prevention Act                       |
| PFOA and compounds           | Including but not limited to the substances in Appendix D      | ≤ 1 µg/m <sup>2</sup> coated area        | Textiles and other coated materials   | Surfactant, impregnation agent in textiles  | Norway FOR-2004-06-01-922<br>EU 2017/1000                                 |
|                              |  | 25 ppb                                   | All other materials   |   |   |
| PFOS and compounds           | Including but not limited to the substances in Appendix D      | ≤ 1 µg/m <sup>2</sup> coated area        | Textiles and other coated materials   | Surfactant, impregnation agent in textiles  | 2004/850/EU   |
|                              |  | 10 ppm                                   | Preparations  |   |   |
|                              |  | 1000 ppm total content                   | All other materials   |   |   |
| Phthalates                   | Appendix E   | 1000 ppm total content                   | All materials   | Plasticizer   | California Proposition 65<br>REACH 1907/2006 and amendments<br>2011/65/EU |

| Chemical                                | CAS No.   | Threshold   | Scope  | Examples   | References   |
|---|---|---|--|--|--|
| Polycyclic Aromatic Hydrocarbons (PAHs) | Appendix F  | 1 ppm individually<br>10 ppm for sum of total PAHs  | External materials                                   | Carbon black, plastics, dyes, combustion by-products   | EC/1272/2013<br>Apple Policy   |
| Polybrominated Biphenyls (PBB)          | 59536-65-1<br>Several   | 1000 ppm and Br < 900 ppm   | All materials  | Flame retardants   | 2011/65/EU<br>GB/T 26572<br>Apple Policy   |
| Polybrominated Diphenyl Ethers (PBDE)   | 1163-19-5<br>Several  | 1000 ppm and Br < 900 ppm   | All materials  | Flame retardants   | 2011/65/EU<br>GB/T 26572<br>Apple Policy   |
| Polychlorinated Biphenyl (PCB)          | 1336-36-3<br>Several  | Non-detect (< 0.1 ppm)  | All materials  | Capacitor, transformer, heat transfer fluids, lubricants   | 2004/850/EU<br>85/467/EEC<br>CRS 001/1983, Brazil  |
| Polychlorinated Naphthalene (PCN)       | 70776-03-3  | 5 ppm   | All materials  | Lubricant, paint, cable insulation, wood preservatives, lubricants, electroplating masking compounds, feedstock for dye production, dye carriers, capacitor fluids, flame proofing, preservatives, moisture proofing sealant, temporary binders for ceramic component manufacturing, casting material for alloys | Apple Policy   |
| Polychlorinated Terphenyl (PCT)         | 61788-33-8  | 5 ppm   | All materials  | Capacitor, transformer, heat transfer fluids, lubricants   | 85/467/EEC<br>REACH 1907/2006<br>and amendments<br>Apple Policy  |
| Polyvinyl Chloride (PVC)                | 9002-86-2   | 900 ppm Cl  | All materials  | Electrical insulator, wire, tape, tubing, cable enclosure, vibration dampener, films   | Apple Policy   |
|   |   | 1500 ppm (Cl + Br)  |  |  |  |
| Radioactive Substances                  | Several   | Detectable levels of ionized radiation in parts, components, materials, and products above regional background levels. Restrictions under international regulations will apply, if appropriate. Any exceedance above the background levels must be reviewed and preapproved by Apple. | All materials  | Electrical sensor, phosphorescent ink  | Japanese Laws for the Regulation of Nuclear Source Material, Nuclear Fuel Material, and Reactors, 1986 |
| REACH Annex XVII                        | Check the ECHA website for the individual restrictions at <a href="https://echa.europa.eu/substances-restricted-under-reach">https://echa.europa.eu/substances-restricted-under-reach</a> | As applicable   | All materials  | REACH, Annex XVII  | REACH 1907/2006<br>and amendments  |
| REACH Candidate List of SVHCs           | Check the ECHA website for the updated list at <a href="http://echa.europa.eu/candidate-list-table">http://echa.europa.eu/candidate-list-table</a>  | 1000 ppm  | Applies to all materials unless preapproved by Apple | REACH, Candidate List  | REACH 1907/2006<br>and amendments<br>Apple Policy  |
| Tetrabromobisphenyl A (TBBA, TBBPA)     | 79-94-7   | 900 ppm Br  | All materials  | Flame retardant for electrical insulator, wire, tape, tubing, cable enclosure, vibration dampener  | Apple Policy   |
|   |   | 1500 ppm (Cl + Br)  |  |  |  |

## 4. Reportable Substances and Future Restrictions in Products

Suppliers are required to report the use of all substances listed in Section 4 regardless of phase out priority in any homogeneous materials used in Apple products, accessories, and packaging. In some cases, reporting is required if the substances exceed a defined permissible limit. Apple is prioritizing the chemicals it intends to phase out of Apple products in order to work effectively with its supply chain. Suppliers are required to report via FMD Portal and/or Test Report Mapping (TRM) form prior to use in Apple products for evaluation and approval for use.

| Chemical                                   | CAS No.  | Threshold   | Examples  | Phase Out Priority | References                                     |
|--|--|---|---|--------------------|--|
| Benzene                                    | 71-43-2  | 100 ppm in the wet formulation  | Solvents in paints, coatings, inks, adhesives, primers  | 1                  | Apple Policy                                   |
| Chlorinated Organic Solvents               | Appendix G   | 1000 ppm in the wet formulation   | Solvents in paints, coatings, inks, adhesives, primers  | 1                  | Apple Policy                                   |
| Toluene                                    | 108-88-3   | 1000 ppm in the wet formulation   | Solvents in paints, coatings, inks, adhesives, primers  | 1                  | Apple Policy                                   |
| Bisphenol F<br>Bisphenol S                 | 620-92-8<br>2467-02-9<br>1333-16-0<br>80-09-1  | 100 ppm   | Adhesives, plastics, epoxy resin  | 2                  | Apple Policy                                   |
| n-Propyl Bromide (nPB)                     | 106-94-5   | 100 ppm   | Cleaning solvent and used as an intermediate in the synthesis of quaternary ammonium compounds. Also used as a solvent in adhesive sprays | 2                  | Apple Policy                                   |
| Parts/Components utilizing RoHS exemptions | <a href="http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm">http://ec.europa.eu/environment/waste/rohs_eee/index_en.htm</a>  | Individual substance thresholds as per the RoHS directive   |   | 2                  | 2011/65/EU                                     |
| Volatile Organic Compounds (VOCs)          | Several  | Report detectable levels. Vendors must meet all applicable VOC regulations in the areas in which they are operating | Paints, coatings, inks, adhesives, primers, cleaners, degreasers  | 2                  | Apple Policy                                   |
| Additive Phosphorous Flame Retardants      | Examples include substances in Appendix L  | 1000 ppm  | Plastics, printed circuit boards  | Reportable         | Sweden Chemical Tax (2016:1067)                |
| Aminoethyl ethanolamine                    | 111-41-1   | Detectable levels   | Paints, lacquers, varnishes, textiles, corrosion inhibitors   | Reportable         | Canadian Environmental Protection Act, 1999    |
| Biocides                                   | Several<br><a href="https://echa.europa.eu/regulations/biocidal-products-regulation/understanding-bpr">https://echa.europa.eu/regulations/biocidal-products-regulation/understanding-bpr</a> | Detectable levels. Treated articles must use biocides that are approved or under review                             | Additive in polymers, leather, other coated materials   | Reportable         | EU No 528/2012 (BPR)                           |
| Cobalt<br>Cobalt Compounds                 | 7440-48-4<br>Several   | 1000 ppm  | Moisture indicator, additive in rubber, cobalt alloys   | Reportable         | REACH 1907/2006 and amendments<br>Apple Policy |
| Diphenylamines, Substituted (SDPA)         | Appendix H   | Detectable levels   | Antioxidants used in adhesives, resins, polymer coatings, paper products  | Reportable         | Canadian Environmental Protection Act, 1999    |



| Chemical  | CAS No.   | Threshold  | Examples   | Phase Out Priority   | References   |
|---|---|--|--|--|--|
| Endocrine Disrupting Chemicals (EDCs)                                   | Examples include substances in Appendix K   | Detectable levels  | All materials  | Reportable   | Apple Policy   |
| IEC 62474 Substances  | <a href="http://std.iec.ch/iec62474">http://std.iec.ch/iec62474</a>   | Various, as required by standard   | All materials  | Reportable unless otherwise restricted within this specification | Apple Policy   |
| Indium Phosphide  | 22398-80-7  | Detectable levels  | Electronic components  | Reportable   | Apple Policy   |
| Nanomaterials   | Several   | Detectable levels  | Silver nanoparticles, carbon nanotubes and graphene, nano-scale cerium dioxide, nano titanium dioxide, nano-scale iron, nanometer-sized copper particles | Reportable   | France Decree No. 2012-232, Environmental Code Article L. 523-4—Annual declaration of substances in nanoparticle 2011/696/EU |
| Per- and Polyfluoroalkyl Substances (PFAS)                              | Examples include substances in Appendix M   | Detectable levels  | Surfactant, impregnation agent in textiles   | Reportable   | Apple Policy   |
| Proposition 65 list of chemicals  | <a href="http://oehha.ca.gov/prop65/prop65_list/Newlist.html">http://oehha.ca.gov/prop65/prop65_list/Newlist.html</a>           | Detectable levels  | All materials  | Reportable   | California Proposition 65  |
| Washington State's List of Chemicals of High Concern to Children (CHCC) | <a href="http://apps.leg.wa.gov/WAC/default.aspx?cite=173-334-130">http://apps.leg.wa.gov/WAC/default.aspx?cite=173-334-130</a> | Practical quantification limit (PQL) if added intentionally<br>100 ppm if present as a contaminant | All materials  | Reportable   | Children's Safe Products Act   |

## 5. Notifying Apple of Chemical Phase Out and Reformulation from Suppliers

Suppliers are required to communicate promptly any changes in chemical manufacturing processes, manufacturing site changes, or any other change that will affect any attribute of the material either in its chemical composition (intentional or residual) or its lead time. For example, if for environmental or other purposes you wish to modify the goods or the processes, production lines, or site(s) used to manufacture the goods in any way after qualification by Apple, you must provide Apple with the reason (e.g., an internal initiative to a phase out or to reformulate any material/part due to a chemical or any other concern), by contacting your Apple Global Supply Manager(s) or the Apple Environmental Team at [environment@apple.com](mailto:environment@apple.com) prior to any such modification. Apple will review your submission and decide whether, or to what extent, a modification is permitted. Subject to the above, you agree to not modify the goods or the processes used to manufacture the goods in any way after qualification without Apple's prior written consent.

## 6. Restrictions in Manufacturing Processes

Restrictions in Section 6 apply to manufacturing processes used to create components or materials for Apple products and the assembly of Apple products. Test reports are required to demonstrate compliance; see Section 9. For all other chemicals, suppliers shall use the most stringent applicable occupational exposure limits (OELs). Per the Apple Supplier Code of Conduct, suppliers shall identify, evaluate, and manage occupational health and safety hazards through a prioritized process of hazard elimination, engineering controls, and/or administrative controls. Suppliers shall provide workers with suitable job-related, appropriately maintained personal protective equipment and instruction on its proper use. Suppliers must comply with all applicable occupational exposure limits for the chemicals listed in this section.

| Chemical                        | CAS No.  | Threshold                                    | Scope  | References                                 |
|---------------------------------|--|--|--|--|
| Benzene                         | 71-43-2  | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |
| Beryllium Dust and Fumes        | 7440-41-7  | Breathing zone<br>< 0.0002 mg/m <sup>3</sup> | Connector contacts, EMI finger (beryllium-copper alloys), transceivers (beryllium oxide) | California OSHA PEL (2006)<br>GBZ 2.1 2007 |
| Chlorinated Organic Solvents    | All Chlorinated Organic Solvents. See Appendix G for examples. | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |
| n-Hexane                        | 110-54-3   | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |
| N-methylpyrrolidone (NMP)       | 872-50-4   | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |
| n-Propyl Bromide (nPB)          | 106-94-5   | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |
| Ozone Depleting Chemicals (ODC) | Appendix I and Appendix J                                      | No intentional use                           | All manufacturing processes  | Montreal Protocol<br>EC No. 2037/2000      |
| Toluene                         | 108-88-3   | Non-use                                      | Cleaning agents, degreasers, demolder solutions in all manufacturing processes           | Apple Policy                               |

## 7. Reportable Substances and Future Restrictions in Manufacturing Processes

Suppliers are required to report the use of substances listed in Section 7 in any manufacturing process used to create components or materials for Apple products regardless of phase out priority. Apple is prioritizing the chemicals it intends to phase out of Apple manufacturing processes in order to work effectively with its supply chain. Suppliers are required to report use to chemmap@apple.com. Apple may require disclosure of the chemical composition and use of manufacturing process chemicals as deemed necessary.

| Chemical                     | CAS No.  | Threshold                   | Scope                       | Phase Out Priority | References   |
|------------------------------|--|-----------------------------|-----------------------------|--------------------|--------------|
| Benzene                      | 71-43-2  | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| Brominated Organic Solvents  | Several  | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| Chlorinated Organic Solvents | All Chlorinated Organic Solvents. See Appendix G for examples. | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| n-Hexane                     | 110-54-3   | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| N-methylpyrrolidone (NMP)    | 872-50-4   | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| n-Propyl Bromide (nPB)       | 106-94-5   | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |
| Toluene                      | 108-88-3   | Detectable levels (Content) | All manufacturing processes | Reportable         | Apple Policy |

## 8. Supplementary Specifications

All Apple products must comply with the restrictions listed in this Regulated Substances Specification. In cases when new restrictions are introduced over a transition period, Apple may release supplementary specifications referencing those specific restrictions. Drawings, fabrication notes, and product specifications will reference the supplementary specification if those restrictions apply. These supplementary specifications are available to qualified suppliers upon request by contacting Apple at [environment@apple.com](mailto:environment@apple.com).

### 8.1 Apple Environmental Quality Specification, 069-8496

The Apple Environmental Quality Specification sets forth Apple's requirements for final assembly facilities, module suppliers, and component suppliers to maintain an environmental quality control program to ensure Apple products environmental compliance. The facility and supplier's environmental quality control program will include a material declaration process, in-process control, and raw materials and finished goods audits. All final assembly facilities and module suppliers are required to adhere to these requirements and provide information to Apple in a timely manner.

### 8.2 Apple Regulated Substances Specification for Prolonged Skin Contact Materials, 099-3470

The Apple Regulated Substance Specification for Prolonged Skin Contact Materials applies to materials intended for prolonged skin contact and used in wearable devices as shipped to Apple's customers.

### 8.3 Conflict Minerals Restrictions, 069-5202

All suppliers of materials, parts, sub-components, components, or products (Component Goods) that are to be incorporated into an Apple product and containing tantalum, tungsten, tin, and gold must comply with the specification on Conflict Minerals Restrictions, 069-5202. Suppliers may only use tin, tantalum, tungsten, or gold in Component Goods if the supplier demonstrates that it has exercised due diligence in the sourcing of such materials and reports to Apple on the source and chain of custody of such metals in accordance with the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, to determine whether those metals are from the Democratic Republic of the Congo (DRC) or any adjoining country and, if so, whether

those metals directly or indirectly financed or benefited armed groups that are perpetrators of serious human rights abuses in the DRC or an adjoining country. Suppliers may only source tin, tantalum, tungsten, or gold through smelters and refiners participating in a conflict-free verification of their sourcing practices by an independent third-party organization or program recognized by Apple. Apple expects each supplier to provide complete and accurate reporting of its due diligence efforts for all tin, tantalum, tungsten, and gold used in Apple Component Goods. Apple will audit suppliers' Conflict Minerals data submissions to ensure conformity with Apple requirements. If any supplier becomes aware that it has sourced tin, tantalum, tungsten, or gold that is from the DRC or any adjoining country and that directly or indirectly financed or benefited armed groups, in any Component Goods incorporated into Apple products, the supplier must immediately notify Apple in writing at [conflictfree@apple.com](mailto:conflictfree@apple.com).

## 9. Demonstrating Compliance

Apple may request analytical test reports demonstrating compliance to any of the substances listed in this specification, at the supplier's expense.

Apple requires test reports from certified labs as proof of compliance for the following substances in homogeneous materials:

| Substance   | Test Results Required for:  | Test Method   |
|---|---|---|
| Arsenic (As)  | Glass   | Total acid digestion followed by ICP-MS                                     |
| Beryllium   | Metals and Ceramics<br>For metals, alloys, and solder, it is acceptable to submit a Certified Mill Test Report (also known as a Mill Test Certificate) in lieu of a test report if it provides full composition information | US EPA 3050B<br>US EPA 3052<br>Others preapproved by Apple                  |
| Bromine (Br)<br>Chlorine (Cl)   | All materials except metals and ceramics  | EN 14582<br>US EPA SW-846 5050/9056<br>Others preapproved by Apple          |
| Cadmium (Cd)<br>Hexavalent Chromium (Cr <sup>6+</sup> )<br>Lead (Pb)<br>Mercury (Hg)<br>Polybrominated biphenyl (PBB)<br>Polybrominated diphenyl ether (PBDE)<br>Bis(2-ethylhexyl) phthalate (DEHP)<br>Butyl benzyl phthalate (BBP)<br>Dibutyl phthalate (DBP)<br>Diisobutyl phthalate (DIBP) | All materials.<br>Test reports are not required for PBB, PBDE, DEHP, BBP, DBP, and DiBP in metals, glass, or ceramic  | Methods described or referenced in IEC 62321<br>Others preapproved by Apple |
| PFOS<br>PFOA  | Inks, paints, leather, textiles, and coatings   | DIN CEN/TS 15968<br>Others preapproved by Apple                             |

Apple requires test reports from certified labs as proof of compliance for the following manufacturing process chemicals:

| Substance                    | Test Results Required for:  | Test Method  |
|------------------------------|---|--|
| Benzene                      | Cleaning agents and degreasers used in all manufacturing operations | Solvent extraction, analyzed by GC-MS or HPLC-MS<br>5 ppm Minimum Detection Limit                      |
| Chlorinated Organic Solvents |   | EN 14582 for total chlorine<br>50 ppm Minimum Detection Limit<br>Others preapproved by Apple           |
| n-Hexane                     |   | Solvent extraction, analyzed by GC-MS or HPLC-MS<br>5 ppm Minimum Detection Limit                      |
| N-Methylpyrrolidone (NMP)    |   | Solvent extraction, analyzed by GC-MS or HPLC-MS<br>5 ppm Minimum Detection Limit                      |
| n-Propyl Bromide (nPB)       |   | EN 14582 for total bromine<br>50 ppm Minimum Detection Limit (EN 14582)<br>Others preapproved by Apple |
| Toluene                      |   | Solvent extraction, analyzed by GC-MS or HPLC-MS<br>5 ppm Minimum Detection Limit                      |

All test reports must meet the following requirements:

- Test reports must be no more than two years old from the date submitted to Apple or Apple's manufacturing partners. Materials tested must be homogeneous. Test reports that are not at a homogeneous material level are not acceptable (e.g., modules made up of several homogeneous materials tested after grinding the entire subassembly).
- Apple requires unaltered test reports from certified labs as proof of compliance for the substances listed in Section 9. Digital test reports must be in the form of original, unaltered PDF files containing text and images as provided by the certified lab(s). Scanned, photographed, modified, and/or image-only PDF files are prohibited without Apple's prior approval.
- A nationally or internationally certified laboratory must issue the test report. Supplier-owned laboratories are acceptable if they are independently certified and evidence of certification must be submitted to [environment@apple.com](mailto:environment@apple.com) for approval. One example of international certification is ISO 17025.
- Testing for substances restricted by RoHS should be performed using methods referenced in IEC 62321, or other test methods preapproved by Apple. Testing for bromine and chlorine must be performed according to method EN 14582, EPA SW-846 5050/9056, or other test methods preapproved by Apple. Test reports based on X-ray Fluorescence Spectroscopy (XRF) are not acceptable forms of compliance documentation.
- Testing must be conducted on the material in the form present in the final Apple product, accessory, or retail packaging item (i.e., "dry" or "cured").
- Test reports submitted to Apple must be issued in English or include English if a bilingual report.
- It is the supplier's responsibility to provide test reports at its expense.

Apple or Apple's manufacturing partners may request renewed test reports on a case-by-case basis, at the supplier's expense, if there are concerns regarding the validity of the test data or compliance of the parts.

All compliance documentation (e.g., test reports and declarations) must be retained by the supplier for a minimum of 10 years as part of the supplier's record-keeping process. Digital formats are acceptable unless otherwise noted. Suppliers are also expected to have compliance assurance processes and systems to control and maintain compliance. Refer to the Apple Environmental Quality Specification (069-8496) for additional information on supplier's internal environmental quality assurance requirements. For substances that are restricted or regulated and have been replaced with an alternative substance, the supplier is required to ensure the alternative substance is an environmentally responsible substitution. Substitutions

should be selected based on minimizing unintended consequences that might occur in phasing out a potentially hazardous substance. Suppliers shall conduct alternative assessments or obtain these assessments from their raw materials suppliers prior to making a replacement. Contact Apple at [environment@apple.com](mailto:environment@apple.com) for more information on conducting alternative assessments. Questions relating to test requirements may be directed to Apple Global Supply Managers (GSM), or emailed to Apple at [environment@apple.com](mailto:environment@apple.com).

## 10. Waiver Process

Suppliers that are seeking an exemption or temporary waiver of restrictions in the Apple Regulated Substances Specification must make the request to Apple in writing. Apple will review the request and provide its decision via email to the requester. Contact Apple at [environment@apple.com](mailto:environment@apple.com) for more information on this process.

## 11. Full Material Disclosure (FMD)

Apple has implemented the Full Material Disclosure (FMD) initiative that requires suppliers to provide the entire chemical composition of the parts and materials used in Apple products as part of the material qualification process. Implementation of FMD requires suppliers to disclose the complete, accurate, and precise identity of the parts and materials used in Apple products. Apple's Full Material Disclosure (FMD) requirements are documented in the FMD Data Requirements for Part Suppliers (080-00316) and the FMD Data Requirements for Material Suppliers (080-01462) specifications. The use of the FMD data collected from suppliers is governed by the Apple FMD Data Use Policy (080-00967), which restricts access to and use of the FMD data submitted to Apple.

Apple will audit supplier FMD data submissions to ensure conformity with the requirements. Apple will conduct analysis to ensure submissions accurately reflect the composition of the parts and materials provided. The analysis will include comparison of FMD data to supplier-provided test reports and may include comparison to Apple test reports. Please contact [FMD\\_Support@apple.com](mailto:FMD_Support@apple.com) for more information.

## 12. Revision History

| Revision | Date              | Revision Description   |
|----------|-------------------|--|
| K        | March 30, 2018    | Updated Scope to include supplier requirements. Updated restriction on BPA. Split PFOA and PFOS into separate listings and updated PFOA restriction. Added restriction on REACH Candidate List of SVHCs, HBCDD. Moved listing for Radioactive Substances from reportable to restricted. Updated restrictions for Cadmium, Chlorine, Bromine, Hexavalent Chromium, Lead, and Mercury to include “compounds.” Created separate restriction listing for Heavy Metals in packaging. Updated scope for restriction on PAHs to External Materials. Updated threshold for reportable listings Benzene, Chlorinated Organic Solvents, and Toluene to reference wet formulation. Changed Parts/Components utilizing RoHS exemptions from priority phase out 3 to 2. Added reportable listings, priority 2 phase out listings Bisphenol F/Bisphenol S and VOCs. Added reportable listings for EDCs, Additive Phosphorous Flame Retardants, IEC 62474 substances, Indium Phosphide, PFAS, and Biocides. Changed the priority phase out for several listings to “Reportable.” Added Section “Notifying Apple of Chemical Phase Out and Reformulation from Suppliers.” Added restriction on nPB in manufacturing process. Created new section “Reportable Substances and Future Restrictions in Manufacturing Processes.” Changed Beryllium test results required for Metals and Ceramics. Added requirement for test results for DEHP, BBP, DBP, and DIBP. Added test report requirement for PFOA/PFOS for leather, textiles, and coatings. Added manufacturing chemical test report requirements for nPB. Removed test reports being valid for the life of the component. Added additional requirements for test reports. Updated Appendices D, E, F, and I with additional substances. Created Appendices K, L, and M. |
| J        | March 21, 2016    | Folded the following specifications into 069-0135-J: Apple RoHS Compliance Specification (069-1111), Apple Specification on Restriction of Beryllium (099-3471), and Apple Specification on the Restriction of Bromine and Chlorine (069-1857). Added additional asbestos compounds. Updated Azo dyes, Arylamines, and Anilines into Appendix A. Updated formaldehyde content restrictions. Updated restrictions for lead. Additional CAS numbers added for Perchlorates. Added Appendix B for Chlorinated Paraffins. Added Appendix C for Organotin compounds, Appendix D for Perfluorinated compounds, Appendix E for Phthalates. Lowered the thresholds for PAHs. Lowered the threshold for PCBs. Added reporting requirements for benzene, toluene, and chlorinated solvents, proposition 65 list, Washington State’s List of Chemicals of High Concern, and substances allowed due to RoHS exemptions in section 4. Phase out priorities added to all the items in reportable Section 4. Added Manufacturing Process restrictions for NMP and Toluene in Section 5. Updated content restriction values for Benzene, Chlorinated Organic Solvents, n-Hexane, and Toluene in Section 5. Updated Supplementary Specifications. Updated Section 7, Demonstrating Compliance. Added testing requirements for manufacturing process chemicals. Added Section 9 relating to Full Material Disclosure (FMD).  |
| H        | June 20, 2014     | Updated definition of Homogeneous Material, Separated Reportable Substances into new section; updated requirements for azo dyes, beryllium, BPA, cadmium, halogenated biphenyl methanes, Lacey Act, lead, organic tin, PFOS, PFOA, phthalates, PVC, REACH SVHCs, TBBPA, benzene, n-Hexane, chlorinated solvents, nPB in ODC, conflict minerals; removed Halogens; addition of Soft Goods Regulated Substances and Beryllium Restriction Specifications in Section 6 for Supplementary Specifications; addition of alternative assessment verbiage and testing requirements for cleaning agents and degreasers in Section 7 for Demonstrating Compliance.   |
| G        | April 11, 2013    | Updated REACH SVHCs, arsenic, asbestos, beryllium requirements, new nickel standard. Added REACH 1907/2006 and amendments, reference to RoHS Recast (RoHS 2), CEPA substances, perchlorate, new phthalates, lead in surface coating, PFOA, BPA reporting, benzotriazole, new PAHs, Lacey Act, and EU Timber Regulation, additional ODCs, benzene and n-Hexane restrictions in manufacturing. Removed polystyrene, gallium. Added reference to 069-8496 for supplier QA. Updated Conflict Minerals reference. Added PFOA/PFOS testing requirement for ink and paints.   |
| F        | January 6, 2010   | Added restrictions on DMF, PAH, PFOS, organic tin compounds, formaldehyde in textiles, and certain phthalates. Added notification requirements and restrictions for substances regulated by REACH. Adjusted arsenic limit and added test report requirement for arsenic in glass. Added reference to Conflict Minerals Restriction specification.  |
| E        | October 9, 2007   | Updated format; introduced restrictions on Br, Cl, TBBA, red phosphorus, gallium; updated limits on As, Pb, Cd, Hg, Cr(VI), asbestos, chlorinated paraffins, formaldehyde, diphenyl methanes, nickel, organic Sn, PCB, PCN, PCT, PVC, radioactive substances; added Be to watch list; limited scope restrictions on chlorinated organic solvents.  |
| D        | October 26, 2004  | Updated plastics Pb limit; merged plastics and cables section; added appendix for guidance on Pb restrictions; added appendix with summary table of permissible limits.  |
| C        | August 18, 2004   | Changed format, new substances added, included permissible limits.   |
| B        | February 12, 2003 | Initial release  |
| A        | December 10, 2002 | Initial release  |

## 13. Referenced Documents

**069-5202:** Conflict Minerals Restriction, Apple Inc.

**069-8496:** Apple Environmental Quality Specification, Apple Inc.

**080-00316:** Apple FMD Data Requirements Specification, Apple Inc.

**080-00967:** Apple FMD Data Use Policy, Apple Inc.

**080-01462:** Apple FMD Data Requirements for Material Suppliers, Apple Inc.

**099-3470:** Apple Regulated Substances Specification; Prolonged Skin Contact Materials

**94/62/EC:** Directive of the European Parliament and of the Council on Packaging and Packaging waste, 94/62/EC, December 1994.

**2004/850/EU:** European Parliament and the Council of the European Union adopted a Regulation on persistent organic pollutants (2004/850/EC) amending Directive 79/117/EEC in April 2004.

**2009/425/EC:** Commission Decision 2009/425/EC of 28 May 2009 amending Council Directive 76/769/EEC: As regards restrictions on the marketing and use of organostannic compounds for the purpose of adapting its Annex I to technical progress.

**2010/153/EU:** Prolonging the validity of Decision 2009/251/EC requiring Member States to ensure that products containing the biocide dimethylfumarate are not placed or made available on the market.

**2011/65/EU:** The restriction of the use of certain hazardous substances in electrical and electronic equipment ("RoHS Recast"). This directive replaces the 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.

**2011/696/EU:** Commission recommendation of 18 October 2011 on the definition of nanomaterial.

**2013/56/EU:** 2013/56/EU Directive amended 2006/66/EC Directive of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC.

**ACGIH:** American Conference of Governmental Industrial Hygienist (ACGIH), Guide to Occupational Exposure Values, 2013.

**AIHA TWA:** The AIHA Guideline Foundation Workplace Environmental Exposure Levels® (WEELs®) provide guidance for protecting most workers from adverse health effects related to occupational chemical exposures expressed as time-weighted average (TWA).

**Apple Supplier Code of Conduct:** See supplier requirements at [www.apple.com/supplier-responsibility](http://www.apple.com/supplier-responsibility).

**Bedarfsgegenstände Verordnung:** German National Law (consumer article regulation).

**CA DTSC:** California Department of Toxic Substances Control; Perchlorate Contamination Prevention Act of 2003, AB 826.

**Cal OSHA:** California Department of Public Health, Occupational Health Branch, PELs, Title 8, section 5155/AC-1.

**California Prop 65:** The Safe Drinking Water and Toxic Enforcement Act of 1986, California Health and Safety Code, Division 20, Chapter 6.5, sections 25249.5 through 25249.13.

**Canadian Environmental Protection Act, 1999 (CEPA 1999):** Chemicals Management Plan, Section 71.

**ChemVerbotsV:** Chemical Prohibition Ordinance, Germany.

**Children's Safe Products Act (CSPA):** Washington State's Children's Safe Products Act reporting List of Chemicals of High Concern to Children (CHCC), US.

**China RoHS:** Administration methods for use of hazardous substance in electrical and electronic products, Ministry of Industry and Information Technology of People's Republic of China, Order#32, January 21, 2016.

**CLP Regulation (EC) No. 1272/2008:** Classification, Labeling and Packaging complements Dangerous Substances Directive (67/548/EEC) and the Dangerous Preparations Directive (1999/45/EC) replaced by EU REACH Directive.

**CPSIA, 2008:** Consumer Product Safety Improvement Act of 2008—Public Law 110-314; US.

**CRS 001/1983:** Executive Directive CRS 001/1983 Regulates Procedures for the Handling, Storage, and Transport of PCB-Contaminated Equipment in Brazil.

**DIN CEN/TS 15968:** Determination of extractable perfluorooctane sulfonates (PFOS) in coated and impregnated solid articles, liquids, and fire fighting foams.

**DIN EN ISO 17075:** Leather—Chemical Tests—Determination of chromium(VI) content

**EC No. 2037/2000:** Regulation (EC) No. 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer.

**EC/757/2010:** Commission Regulation (EU) No. 757/2010 amending Regulation (EC) No. 850/2004 of the European Parliament and of the Council on persistent organic pollutants (perfluorooctane sulfonates) as regards Annexes IV and V.

**EU/1272/2013:** Commission Regulation (EU) No. 1272/2013 to amend Entry 50 of Annex XVII to REACH Regulation (EC) No. 1907/2006 on the restrictions of polycyclic aromatic hydrocarbons (PAH).

**ECHA/NA/15/29:** SEAC (Committee for Socio Economic Analysis) concludes on Bisphenol A, DecaBDE, and PFOA restrictions and finalizes two opinions for authorization, September 2015.

**EN 1811:2011:** Reference test method for release of nickel from all post assemblies that are articles intended to come into direct and prolonged contact with the skin. Replaces BS EN 1811:1998+ A1:2008.

**EN 14582:2016:** Characterization of waste. Halogen and sulfur content. Oxygen combustion in closed systems and determination methods. British Standards Institute, 2016.

**EPA SW-846 5050/9056:** Bomb preparation method for solid waste; Method 9056: Determination of inorganic anions by ion chromatography. EPA, 1994.

**EU 2017/1000:** Commission Regulation (EU) 2017/1000 of 13 June 2017 amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) as regards perfluorooctanoic acid (PFOA), its salts and PFOA-related substances.

**EU No. 528/2012 (BPR):** Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products.

**EU Timber Regulation:** Regulation laying down the obligations of operators who place timber and timber products on the market: (EU) No. 995/2010.

**France Decree No. 2012-232, Environmental Code Article L. 523-4:** Annual declaration of nanoparticles in substances.

**GB 18401:** Chinese National General Safety Technical Code for Textile Products: GB 18401–2010.

**GB 20400:** Limit of Harmful Matters in Leather and Fur, 2006 (Chinese mandatory standard).

**GB/T 26572:** Chinese Standards on the Requirements of Concentration Limits for Certain Restricted Substances in Electrical and Electronic Products, 2011.

**GBZ 2.1-2007:** Occupational exposure limits for hazardous agents in the workplace in China, 1 November 2007.

**IEC 62321:** Determination of certain substances in electrotechnical products. IEC, 2008. Updates in 2013 and 2015.

**IEC 62474:** Material Declaration for Products of and for the Electrotechnical Industry.

**IEEE 1680.1-2018:** IEEE Standard for Environmental and Social Responsibility Assessment of Computers and Displays, IEEE, 2018.

**Japan Chemical Substances Control Law (CSCL):** Japanese Chemical Substances Control Law (CSCL) and amendments, 2011.

**Japanese Laws:** Japanese Laws for the Regulation of Nuclear Source Material, Nuclear Fuel Material, and Reactors, 1986.

**Lacey Act (16 U.S.C. §§ 3371–3378):** Amended in the Food, Conservation, and Energy Act of 2008 (Pub.L. 110-234, H.R. 2419, 122 Stat. 923, enacted May 22, 2008), expanded its protection to a broader range of plants and plant products (Section 8204. Prevention of Illegal Logging Practices).

**Montreal Protocol:** Montreal Protocol on Substances that Deplete the Ozone Layer, September 1987.

**NIOSH:** National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards, Center for Disease Control and Prevention (CDC), 2014.

**Norway FOR-2004-06-01-922:** Regulations relating to restrictions on the use of health-hazardous chemicals and other products (Product Regulations).

**REACH:** Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).



**REACH 1907/2006 and amendments:** Annex XVII of Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). This Annex replaces the following directives:

**76/769/EEC** (Azocolorants, Arsenic)

**85/467/EEC** (PCB/PCT)

**91/659/EEC** (Asbestos)

**94/27/EC** (Nickel)

**2002/45/EEC** (Short-Chain Chlorinated Paraffins)

**2002/61/EC** (Azocolourants)

**2003/3/EC** (Blue Azocolourants)

**2009/425/EC** (Organotin Compounds)

**REACH, Article 59 (10):** Candidate List of substances of very high concern for Authorisation under REACH regulation.

**Sweden Chemical Tax (2016:1067):** Tax enacted on July 1, 2017, levied on chemicals in certain electronics.

**Taiwan BSMI RoHS:** CNS 15663 is the technique standards of Taiwan BSMI RoHS.

**UL 110:** UL Standard 110, Edition 2, UL 110 Standard for Sustainability for Mobile Phones, UL, 2017.

**US EPA 3050B:** EPA method describing acid digestion of sediments, sludges, and soils.

**US EPA 3052:** EPA method describing microwave assisted acid digestion of siliceous and organically based matrices.

**US EPA 5021A:** Method to determine volatile organic compounds in soils and other solid matrices using equilibrium headspace analysis.

**US EPA, SNUR 2070-AJ73:** EPA's significant new use rule for short-chain chlorinated paraffins, under TSCA Section 5(a)(2), December 2014.

## 14. Appendices

### Appendix A: Azo Dyes, Arylamines, and Anilines

| Azo Dyes, Arylamines, and Anilines [24 items] | CAS No.  |
|---|----------|
| 4-Aminoazobenzene                             | 60-09-3  |
| o-Aminoazotoluene                             | 97-56-3  |
| 2-Amino-4-nitrotoluene                        | 99-55-8  |
| o-Anisidine                                   | 90-04-0  |
| Benzidine                                     | 92-87-5  |
| 2,2'-dichloro-4,4'-methylenedianiline (MOCA)  | 101-14-4 |
| 4-Biphenylamine                               | 92-67-1  |
| 4-Chloroaniline                               | 106-47-8 |
| 4-Chloro-2-toluidine                          | 95-69-2  |
| p-Cresidine                                   | 120-71-8 |
| 2,4-Diaminoanisole                            | 615-05-4 |
| 4,4'-Diaminodiphenylmethane                   | 101-77-9 |
| 2,4-Diaminotoluene                            | 95-80-7  |
| 3,3'-Dichlorobenzidine                        | 91-94-1  |
| 3,3'-Dimethoxybenzidine                       | 119-90-4 |
| 3,3'-Dimethylbenzidine                        | 119-93-7 |
| 3,3'-Dimethyl-4,4'-diaminodiphenylmethane     | 838-88-0 |
| 2-Naphthylamine                               | 91-59-8  |
| 4,4'-Oxydianiline                             | 101-80-4 |
| 4,4'-Thiodianiline                            | 139-65-1 |
| o-Toluidine                                   | 95-53-4  |
| 2,4,5-Trimethylaniline                        | 137-17-7 |
| 2,4-Xylidine                                  | 95-68-1  |
| 2,6-Xylidine                                  | 87-62-7  |

### Appendix B: Chlorinated Paraffins (SCCP and MCCP)

| Chlorinated Paraffins (SCCP and MCCP)  | CAS No.    |
|--|------------|
| Short-Chain Chlorinated Paraffins (SCCPs) $C_xH_{2x+2-y}Cl_y$ , where $x=10-13$ and $y=1-13$ [4 items] | Examples   |
| Alkanes, C10-13, chloro  | 85535-84-8 |
| Alkanes, C10-21, chloro  | 84082-38-2 |
| Alkanes, C12-13, chloro  | 71011-12-6 |
| Alkanes, C12-14, chloro  | 85536-22-7 |
| Medium-Chain Chlorinated Paraffins (MCCPs) $C_xH_{2x+2-y}Cl_y$ , where $x=14-17$ and $y=1-17$ [1 item] | Example    |
| Alkanes, C14-17, chloro  | 85535-85-9 |

### Appendix C: Organotin Compounds

| Organotin Compounds [9 items]     | CAS No.  |
|-----------------------------------|----------|
| Monobutyltin (MBT) Compounds      | Multiple |
| Monooctyltin (MOT) Compounds      | Multiple |
| Dibutyltin (DBT) Compounds        | Multiple |
| Diocetyl tin (DOT) Compounds      | Multiple |
| Tetrabutyltin (TeBT)              | Multiple |
| Tetraoctyltin (TeOT)              | Multiple |
| Tributyltin (TBT) Compounds       | Multiple |
| Tricyclohexyltin (TCyT) Compounds | Multiple |
| Triphenyltin (TPHT) Compounds     | Multiple |

## Appendix D: PFOA and PFOS Compounds

| PFOA and PFOS Compound [2 items]            | CAS No.   |           |
|---|---|-----------|
| Perfluorooctanoic Acid (PFOA) and compounds | 335-67-1  |           |
|   | 3825-26-1                                       |           |
|   | 335-95-5  |           |
|   | 2395-00-8                                       |           |
|   | 335-93-3  |           |
|   | 335-66-0  |           |
|   | 376-27-2  |           |
|   | 3108-24-5                                       |           |
|   | Perfluorooctane Sulfonates (PFOS) and compounds | 754-91-6  |
|   |   | 1691-99-2 |
| 1763-23-1                                   |   |           |
| 2355-31-9                                   |   |           |
| 24448-09-7                                  |   |           |
| 2795-39-3                                   |   |           |
| 2806-24-8                                   |   |           |
| 2991-50-6                                   |   |           |
| 29081-56-9                                  |   |           |
| 29457-72-5                                  |   |           |
| 70225-14-8                                  |   |           |

## Appendix E: Phthalates

| Phthalates [21 items]  | CAS No.                  |
|--|--------------------------|
| 1,2-Benzenedicarboxylic acid, di-C6-8-branched alkyl esters, C7-rich (DIHP)  | 71888-89-6               |
| 1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters; 1,2-Benzenedicarboxylic acid, mixed decyl and hexyl and octyl diesters with ≥ 0.3% of dihexyl phthalate | 68515-51-5<br>68648-93-1 |
| 1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters (DHNUF)  | 68515-42-4               |
| 1,2-Benzenedicarboxylic acid, dipentylester, branched and linear (DPP)   | 84777-06-0               |
| Bis-(2-methoxyethyl) phthalate (DMEP)  | 117-82-8                 |
| Butylbenzyl phthalate (BBP)  | 85-68-7                  |
| Dibutyl phthalate (DBP)  | 84-74-2                  |
| Diethyl phthalate (DEP)  | 84-66-2                  |
| Diethylhexyl phthalate (DEHP)  | 117-81-7                 |
| Diisobutyl phthalate (DIBP)  | 84-69-5                  |
| Di-isodecyl phthalate (DIDP)   | 26761-40-0<br>68515-49-1 |
| Diisononyl phthalate (DINP)  | 28553-12-0<br>68515-48-0 |
| Di-iso-pentyl phthalate (DIPP)   | 605-50-5                 |
| Dimethyl phthalate (DMP)   | 131-11-3                 |
| Di-n-hexyl phthalate (DnHP)  | 84-75-3                  |
| Di-n-Octyl phthalate (DNOP)  | 117-84-0                 |
| Di-n-pentyl phthalate (DnPP)   | 131-18-0                 |
| n-Pentyl-isopentyl phthalate (nPIPP)   | 776297-69-9              |
| Diundecyl phthalate (DuDP)   | 3648-20-2                |
| Dicyclohexyl phthalate (DCHP)  | 84-61-7                  |
| Diisohexyl phthalate (DiHP)  | 68515-50-4               |

## Appendix F: Polycyclic Aromatic Hydrocarbons (PAHs)

| Polycyclic Aromatic Hydrocarbons (PAHs) [27 items] | CAS No.              |
|--|----------------------|
| Acenaphthene                                       | 83-32-9              |
| Acenaphthylene                                     | 208-96-8             |
| Anthracene   | 120-12-7             |
| Benzo(a)anthracene                                 | 56-55-3; 1718-53-2   |
| Benzo(a)phenanthrene (chrysene)                    | 218-01-9             |
| Benzo(a)pyrene                                     | 50-32-8              |
| Benzo(b)fluoranthene                               | 205-99-2             |
| Benzo(e)pyrene                                     | 192-97-2             |
| Benzo(g,h,i)perylene                               | 191-24-2             |
| Benzo(j)fluoranthene                               | 205-82-3             |
| Benzo(k)fluoranthene                               | 207-08-9             |
| Benzo(j,k)fluorene (Fluoranthene)                  | 206-44-0; 93951-69-0 |
| Benzo(r,s,t)pentaphene                             | 189-55-9             |
| Dibenz(a,h)acridine                                | 226-36-8             |
| Dibenz(a,j)acridine                                | 224-42-0             |
| Dibenzo(a,h)anthracene                             | 53-70-3              |
| Dibenzo(a,e)fluoranthene                           | 5385-75-1            |
| Dibenzo(a,e)pyrene                                 | 192-65-4             |
| Dibenzo(a,h)pyrene                                 | 189-64-0             |
| Dibenzo(a,l)pyrene                                 | 191-30-0             |
| 7H-Dibenzo(c,g)carbazole                           | 194-59-2             |
| Fluorene   | 86-73-7              |
| Indeno(1,2,3-cd)pyrene                             | 193-39-5             |
| 5-Methylchrysene                                   | 3697-24-3            |
| Naphthalene  | 91-20-3              |
| Phenanthrene                                       | 85-01-8              |
| Pyrene   | 129-00-0; 1718-52-1  |

## Appendix G: Chlorinated Organic Solvents

| Chlorinated Organic Solvents    | CAS No.  |
|---------------------------------|----------|
| Chlorinated Methanes [6 items]  |          |
| Bromodichloromethane            | 75-27-4  |
| Carbon tetrachloride            | 56-23-5  |
| Chloroform                      | 67-66-3  |
| Dibromochloromethane            | 124-48-1 |
| Methylene chloride              | 75-09-2  |
| Methyl chloride                 | 74-87-3  |
| Chlorinated Ethanes [9 items]   |          |
| Chloroethane                    | 75-00-3  |
| 1,1-Dichloroethane              | 75-34-3  |
| 1,2-Dichloroethane              | 107-06-2 |
| Hexachloroethane                | 67-72-1  |
| Pentachloroethane               | 76-01-7  |
| 1,1,1,2-Tetrachloroethane       | 630-20-6 |
| 1,1,2,2-Tetrachloroethane       | 79-34-5  |
| 1,1,1-Trichloroethane           | 71-55-6  |
| 1,1,2-Trichloroethane           | 79-00-5  |
| Chlorinated Ethylenes [5 items] |          |
| 1,1-Dichloroethylene            | 75-35-4  |
| cis-1,2-Dichloroethylene        | 156-59-2 |
| trans-1,2-Dichloroethylene      | 156-60-5 |
| Tetrachloroethylene             | 127-18-4 |
| Trichloroethylene               | 79-01-6  |

## Appendix H: Diphenylamines, Substituted (SDPA)

| Diphenylamines, Substituted (SDPA) [13 items]   | CAS No.     |
|---|-------------|
| Benzenamine, 4-octyl-N-(4-octylphenyl)-   | 101-67-7    |
| Benzenamine, 4-octyl-N-phenyl-  | 4175-37-5   |
| Benzenamine, 4-(1-methyl-1-phenylethyl)-N-[4-(1-methyl-1-phenylethyl)phenyl]-         | 10081-67-1  |
| Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]-     | 15721-78-5  |
| Benzenamine, 4-nonyl-N-(4-nonylphenyl)-   | 24925-59-5  |
| Benzenamine, ar-octyl-N-(octylphenyl)-  | 26603-23-6  |
| Benzenamine, ar-nonyl-N-phenyl-   | 27177-41-9  |
| Benzenamine, ar-nonyl-N-(nonylphenyl)-  | 36878-20-3  |
| Benzenamine, N-phenyl-, reaction products with 2,4,4-trimethylpentene                 | 68411-46-1  |
| Benzenamine, N-phenyl-, styrenated  | 68442-68-2  |
| Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives                    | 68608-77-5  |
| Benzenamine, N-phenyl-, (tripropenyl) derivatives                                     | 68608-79-7  |
| Benzenamine, N-phenyl-, reaction products with isobutylene and 2,4,4-trimethylpentene | 184378-08-3 |

## Appendix I: Ozone Depleting Chemicals

| Ozone Depleting Chemicals [62 items]   | CAS No.                |
|--|------------------------|
| Trichlorofluoromethane (CFC-11)  | 75-69-4                |
| Dichlorodifluoromethane (CFC-12)   | 75-71-8                |
| Chlorotrifluoromethane (CFC-13)  | 75-72-9                |
| Pentachlorofluoroethane (CFC-111)  | 354-56-3               |
| 1,1,2,2-Tetrachloro-1,2-difluoroethane (CFC-112)                                       | 76-12-0                |
| 1,1,1,2-Tetrachloro-2,2-difluoroethane (CFC-112a)                                      | 76-11-9                |
| 1,1,2-Trichloro-1,2,2 trifluoroethane (CFC-113)  | 76-13-1                |
| 1,1,1-Trichloro-2,2,2 trifluoroethane (CFC-113a)                                       | 354-58-5               |
| Dichlorotetrafluoroethane (CFC-114)  | 76-14-2                |
| Monochloropentafluoroethane (CFC-115)  | 76-15-3                |
| Heptachlorofluoropropane (CFC-211)   | 135401-87-5            |
| 1,1,1,2,2,3,3-Heptachloro-3-fluoropropane (CFC-211aa)                                  | 422-78-6               |
| 1,1,1,2,2,3,3-Heptachloro-2-fluoropropane (CFC-211ba)                                  | 422-81-1               |
| Hexachlorodifluoropropane (CFC-212)  | 3182-26-1              |
| Pentachlorotrifluoropropane (CFC-213)  | 2354-06-5; 134237-31-3 |
| Tetrachlorotetrafluoropropane (CFC-214)  | 29255-31-0             |
| 1,2,2,3-Tetrachloro-1,1,3,3-tetrafluoropropane (CFC-214aa)                             | 2268-46-4              |
| 1,1,1,3-Tetrachloro-2,2,3,3-tetrafluoropropane (CFC-214cb)                             | -                      |
| 1,2,2-Trichloropentafluoropropane (CFC-215aa)  | 1599-41-3              |
| 1,2,3-Trichloropentafluoropropane (CFC-215ba)  | 76-17-5                |
| 1,1,2-Trichloropentafluoropropane (CFC-215bb)  | -                      |
| 1,1,3-Trichloropentafluoropropane (CFC-215ca)  | -                      |
| 1,1,1-Trichloropentafluoropropane (CFC-215cb)  | 4259-43-2              |
| Dichlorohexafluoropropane (CFC-216)  | 661-97-2               |
| Monochloroheptafluoropropane (CFC-217)   | 422-86-6<br>76-18-6    |
| Dibromodifluoromethane (Halon 1202)  | 75-61-6                |
| Bromochlorodifluoromethane (Halon 1211)  | 353-59-3               |
| Bromotrifluoromethane (Halon 1301)   | 75-63-8                |
| Dibromotetrafluoroethane (Halon 2402)  | 124-73-2               |
| Tetrachloromethane (carbon tetrachloride)  | 56-23-5                |
| 1,1,1-Trichloroethane (methyl chloroform) and its isomers except 1,1,2-trichloroethane | 71-55-6                |

## Appendix I: Ozone Depleting Chemicals continued

| Ozone Depleting Chemicals                     | CAS No.               |
|---|-----------------------|
| Bromomethane (methyl bromide)                 | 74-83-9               |
| Bromoethane (ethyl bromide)                   | 74-96-4               |
| 1-Bromopropane (n-propyl bromide)             | 106-94-5              |
| Trifluoroiodomethane (trifluoromethyl iodide) | 2314-97-8             |
| Chloromethane (methyl chloride)               | 74-87-3               |
| Dibromofluoromethane                          | 1868-53-7             |
| Bromodifluoromethane                          | 1511-62-2             |
| Bromofluoromethane                            | 373-52-4              |
| Tetrabromofluoroethane                        | 306-80-9              |
| Tribromodifluoroethane                        | –                     |
| Dibromotrifluoroethane                        | 354-04-1              |
| Bromotetrafluoroethane                        | 124-72-1              |
| Tribromofluoroethane                          | –                     |
| Dibromodifluoroethane                         | 75-82-1               |
| Bromotrifluoroethane                          | 421-06-7              |
| Dibromofluoroethane                           | 358-97-4              |
| Bromodifluoroethane                           | 420-47-3, 357188-74-0 |
| Bromofluoroethane                             | 762-49-2              |
| Hexabromofluoropropane                        | –                     |
| Pentabromodifluoropropane                     | –                     |
| Tetrabromotrifluoropropane                    | –                     |
| Tribromotetrafluoropropane                    | –                     |
| Dibromopentafluoropropane                     | 431-78-7              |
| Bromohexafluoropropane                        | 2252-78-0             |
| Pentabromofluoropropane                       | –                     |
| Tetrabromodifluoropropane                     | –                     |
| Tribromotrifluoropropane                      | –                     |
| Dibromotetrafluoropropane                     | –                     |
| Bromopentafluoropropane                       | 460-88-8              |

| Ozone Depleting Chemicals | CAS No.    |
|---------------------------|------------|
| Tetrabromofluoropropane   | –          |
| Tribromodifluoropropane   | 70192-80-2 |
| Dibromotrifluoropropane   | 431-21-0   |
| Bromotetrafluoropropane   | 679-84-5   |
| Tribromofluoropropane     | 75372-14-4 |
| Dibromodifluoropropane    | 460-25-3   |
| Bromotrifluoropropane     | 421-46-5   |
| Dibromofluoropropane      | 51584-26-0 |
| Bromodifluoropropane      | –          |
| Bromofluoropropane        | 1871-72-3  |
| Bromochloromethane        | 74-97-5    |
| Sulfur hexafluoride       | 2551-62-4  |

## Appendix J: Ozone Depleting Chemicals—Hydrochlorofluorocarbons

| Hydrochlorofluorocarbons [34 items]            | CAS No.    |
|--|------------|
| Dichlorofluoromethane (HCFC-21)                | 75-43-4    |
| Chlorodifluoromethane (HCFC-22)                | 75-45-6    |
| Chlorofluoromethane (HCFC-31)                  | 593-70-4   |
| 1,1,2,2-Tetrachloro-1-fluoroethane (HCFC-121)  | 354-11-0   |
| 1,1,1,2-Tetrachloro-2-fluoroethane (HCFC-121a) | 354-14-3   |
| Trichlorodifluoroethane (HCFC-122)             | 41834-16-6 |
| 1,2,2-Trichloro-1,1-difluoroethane (HCFC-122)  | 354-21-2   |
| 1,1,2-Trichloro-1,2-difluoroethane (HCFC-122a) | 354-15-4   |
| 1,1,1-Trichloro-2,2-difluoroethane (HCFC-122b) | 354-12-1   |
| Dichlorotrifluoroethane (HCFC-123)             | 34077-87-7 |
| Dichloro-1,1,2-trifluoroethane                 | 90454-18-5 |
| 2,2-dichloro-1,1,1-trifluoroethane             | 306-83-2   |
| 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a) | 354-23-4   |
| 1,1-dichloro-1,2,2-trifluoroethane (HCFC-123b) | 812-04-4   |
| Chlorotetrafluoroethane (HCFC-124)             | 63938-10-3 |
| 2-chloro-1,1,1,2-tetrafluoroethane             | 2837-89-0  |
| 1-chloro-1,1,2,2-tetrafluoroethane (HCFC-124a) | 354-25-6   |
| Trichlorofluoroethane (HCFC-131)               | 27154-33-2 |
| 1-Fluoro-1,2,2-trichloroethane                 | 359-28-4   |
| 1,1,2-Trichloro-1-fluoroethane (HCFC-131a)     | 811-95-0   |
| 1,1,1-trichloro-2-fluoroethane (HCFC-131b)     | 2366-36-1  |
| Dichlorodifluoroethane (HCFC-132)              | 25915-78-0 |
| 1,2-Dichloro-1,2-difluoroethane (HCFC-132)     | 431-06-1   |
| 1,1-Dichloro-2,2-difluoroethane (HCFC-132a)    | 471-43-2   |
| 1,2-Dichloro-1,1-difluoroethane (HCFC-132b)    | 1649-08-7  |
| 1,1-Dichloro-1,2-difluoroethane (HCFC-132c)    | 1842-05-3  |
| Chlorotrifluoroethane (HCFC-133)               | 431-07-2   |
| 1-Chloro-1,2,2-trifluoroethane (HCFC-133)      | 1330-45-6  |
| 2-Chloro-1,1,1-trifluoroethane (HCFC-133a)     | 75-88-7    |
| 1-Chloro-1,1,2-trifluoroethane (HCFC-133b)     | 421-04-5   |
| Dichlorofluoroethane (HCFC-141)                | 25167-88-8 |
| 1,2-Dichloro-1-fluoroethane (HCFC-141)         | 430-57-9   |
| 1,1-Dichloro-2-fluoroethane (HCFC-141a)        | 430-53-5   |
| 1,1-Dichloro-1-fluoroethane (HCFC-141b)        | 1717-00-6  |
| Chlorodifluoroethane (HCFC-142)                | 25497-29-4 |
| 2-Chloro-1,1-difluoroethane (HCFC-142)         | 338-65-8   |
| 1-Chloro-1,1-difluoroethane (HCFC-142b)        | 75-68-3    |
| 1-Chloro-1,2-difluoroethane (HCFC-142a)        | 338-64-7   |

| Hydrochlorofluorocarbons                                | CAS No.                 |
|---|-------------------------|
| Chlorofluoroethane (HCFC-151)                           | 110587-14-9             |
| 1-Chloro-2-fluoroethane (HCFC-151)                      | 762-50-5                |
| 1-Chloro-1-fluoroethane (HCFC-151a)                     | 1615-75-4               |
| Hexachlorofluoropropane (HCFC-221)                      | 134237-35-7, 29470-94-8 |
| 1,1,1,2,2,3-Hexachloro-3-fluoropropane (HCFC-221ab)     | 422-26-4                |
| Pentachlorodifluoropropane (HCFC-222)                   | 134237-36-8             |
| 1,1,1,3,3-pentachloro-2,2-difluoropropane (HCFC-222ca)  | 422-49-1                |
| 1,2,2,3,3-pentachloro-1,1-difluoropropane (HCFC-222aa)  | 422-30-0                |
| Tetrachlorotrifluoropropane (HCFC-223)                  | 134237-37-9             |
| 1,1,3,3-Tetrachloro-1,2,2-trifluoropropane (HCFC-223ca) | 422-52-6                |
| 1,1,1,3-Tetrachloro-2,2,3-trifluoropropane (HCFC-223cb) | 422-50-4                |
| Trichlorotetrafluoropropane (HCFC-224)                  | 134237-38-0             |
| 1,3,3-Trichloro-1,1,2,2-tetrafluoropropane (HCFC-224ca) | 422-54-8                |
| 1,1,3-Trichloro-1,2,2,3-tetrafluoropropane (HCFC-224cb) | 422-53-7                |
| 1,1,1-Trichloro-2,2,3,3-tetrafluoropropane (HCFC-224cc) | 422-51-5                |
| Dichloropentafluoropropane (HCFC-225)                   | 127564-92-5             |
| 2,2-Dichloro-1,1,1,3,3-pentafluoropropane (HCFC-225aa)  | 128903-21-9             |
| 2,3-Dichloro-1,1,1,2,3-pentafluoropropane (HCFC-225ba)  | 422-48-0                |
| 1,2-Dichloro-1,1,2,3,3-pentafluoropropane (HCFC-225bb)  | 422-44-6                |
| 3,3-Dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)  | 422-56-0                |
| 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)  | 507-55-1                |
| 1,1-Dichloro-1,2,2,3,3-pentafluoropropane (HCFC-225cc)  | 13474-88-9              |
| 1,2-Dichloro-1,1,3,3,3-pentafluoropropane (HCFC-225da)  | 431-86-7                |
| 1,3-Dichloro-1,1,2,3,3-pentafluoropropane (HCFC-225ea)  | 136013-79-1             |
| 1,1-Dichloro-1,2,3,3,3-pentafluoropropane (HCFC-225eb)  | 111512-56-2             |
| Chlorohexafluoropropane (HCFC-226)                      | 134308-72-8             |
| 2-Chloro-1,1,1,3,3,3-hexafluoro-propane (HCFC-226da)    | 431-87-8                |
| Pentachlorofluoropropane (HCFC-231)                     | 134190-48-0             |
| 1,1,1,2,3-pentachloro-2-fluoro-propane (HCFC-231bb)     | 421-94-3                |
| Tetrachlorodifluoropropane (HCFC-232)                   | 134237-39-1             |
| 1,1,1,3-Tetrachloro-3,3-difluoropropane (HCFC-232fc)    | 460-89-9                |
| Trichlorotrifluoropropane (HCFC-233)                    | 134237-40-4             |
| 1,1,1-Trichloro-3,3,3-trifluoropropane (HCFC-233fb)     | 7125-84-0               |
|   | 7125-83-9               |
| Dichlorotetrafluoropropane (HCFC-234)                   | 127564-83-4             |
| 1,2-Dichloro-1,2,3,3-tetrafluoropropane (HCFC-234db)    | 425-94-5                |
| Chloropentafluoropropane (HCFC-235)                     | 134237-41-5             |
| 1-Chloro-1,1,3,3,3-pentafluoropropane (HCFC-235fa)      | 460-92-4                |
| Tetrachlorofluoropropane (HCFC-241)                     | 134190-49-1             |
| 1,1,2,3-Tetrachloro-1-fluoropropane (HCFC-241db)        | 666-27-3                |

## Appendix J: Ozone Depleting Chemicals—Hydrochlorofluorocarbons continued

| Hydrochlorofluorocarbons  | CAS No.  |
|---|--|
| Trichlorodifluoropropane (HCFC-242)<br>1,3,3-Trichloro-1,1-difluoropropane (HCFC-242fa)   | 134237-42-6<br>460-63-9                            |
| Dichlorotrifluoropropane (HCFC-243)<br>1,1-dichloro-1,2,2-trifluoropropane<br>2,3-dichloro-1,1,1-trifluoropropane<br>3,3-dichloro-1,1,1-trifluoropropane                | 134237-43-7<br>7125-99-7<br>338-75-0<br>460-69-5   |
| Chlorotetrafluoropropane (HCFC-244)<br>3-Chloro-1,1,2,2-tetrafluoropropane (HCFC-244ca)<br>1-Chloro-1,1,2,2-tetrafluoropropane (HCFC-244cc)                             | 134190-50-4<br>679-85-6<br>421-75-0                |
| Trichlorofluoropropane (HCFC-251)<br>1,1,3-Trichloro-1-fluoropropane (HCFC-251fb)<br>1,1,2-Trichloro-1-fluoropropane (HCFC-251dc)                                       | 134190-51-5<br>818-99-5<br>421-41-0                |
| Dichlorodifluoropropane (HCFC-252)<br>1,3-Dichloro-1,1-difluoropropane (HCFC-252fb)   | 134190-52-6<br>819-00-1                            |
| Chlorotrifluoropropane (HCFC-253)<br>3-chloro-1,1,1-trifluoropropane (HCFC-253fb)   | 134237-44-8<br>460-35-5                            |
| Dichlorofluoropropane (HCFC-261)<br>1,1-Dichloro-1-fluoropropane (HCFC-261fc)<br>1,2-Dichloro-2-fluoro-propane (HCFC-261ba)   | 134237-45-9<br>7799-56-6<br>420-97-3               |
| Chlorodifluoropropane (HCFC-262)<br>1-Chloro-2,2-difluoropropane (HCFC-262ca)<br>2-Chloro-1,3-difluoropropane (HCFC-262da)<br>1-Chloro-1,1-difluoropropane (HCFC-262fc) | 134190-53-7<br>420-99-5<br>102738-79-4<br>421-02-3 |
| Chlorofluoropropane (HCFC-271)<br>2-Chloro-2-fluoropropane (HCFC-271ba)<br>1-Chloro-1-fluoropropane (HCFC-271fb)  | 134190-54-8<br>420-44-0<br>430-55-7                |

## Appendix K: Endocrine Disruptors

| Endocrine Disruptors [11 items] | CAS No.    |
|---------------------------------|------------|
| Triphenyl phosphate (TPHP)      | 115-86-6   |
| Butylated hydroxytoluene        | 128-37-0   |
| Ziram                           | 137-30-4   |
| Metam sodium                    | 137-42-8   |
| Thiram                          | 137-26-8   |
| Zineb                           | 12122-67-7 |
| 4-nitrophenol                   | 100-02-7   |
| Resorcinol                      | 108-46-3   |
| Tert-butylhydroxyanisole (BHA)  | 25013-16-5 |
| 4,4'-Dihydroxybenzophenone      | 611-99-4   |
| 3-Benzylidene camphor 3-BC      | 15087-24-8 |

## Appendix L: Additive Phosphorous Flame Retardants

| Additive Phosphorus Flame Retardants [27 items]        | CAS No.                |
|--|------------------------|
| Triphenyl phosphate                                    | 115-86-6               |
| Diphenyl octyl phosphate                               | 115-88-8               |
| 2-Ethylhexyl diphenyl phosphate                        | 1241-94-7              |
| Resorcinol bis(diphenyl phosphate)                     | 57583-54-7             |
| Tri-n-butyl phosphate                                  | 126-73-8               |
| Tricresyl phosphate                                    | 1330-78-5              |
| Dodecyl diphenyl phosphate                             | 27460-02-2             |
| Cetyl diphenyl phosphate                               | 56827-92-0             |
| Diethyl ethanephosphonate                              | 78-38-6                |
| Trixylyl phosphate                                     | 25155-23-1             |
| Aluminum diethylphosphinate                            | 225789-38-8            |
| Diphenyl cresyl phosphate                              | 26444-49-5             |
| Isopropylated triphenyl phosphate                      | 26967-76-0, 72668-27-0 |
| Diethyl N,N'-bis(2-hydroxyethyl)aminomethylphosphonate | 2781-11-5              |
| Zinc diethylphosphinate                                | 284685-45-6            |



## Appendix L: Additive Phosphorous Flame Retardants continued

| Additive Phosphorus Flame Retardants        | CAS No.    |
|---|------------|
| Isodecyl diphenyl phosphate                 | 29761-21-5 |
| Melamine phosphate                          | 41583-09-9 |
| Tetrakis(hydroxymethyl)phosphonium sulphate | 55566-30-8 |
| Tri-m-cresyl phosphate                      | 563-04-2   |
| Tris(4-tert-butylphenyl) phosphate          | 78-33-1    |
| Piperazine pyrophosphate                    | 66034-17-1 |
| Red phosphorous                             | 7723-14-0  |
| Tri-o-cresyl phosphate                      | 78-30-8    |
| Tri-p-cresyl phosphate                      | 78-32-0    |
| Triethyl phosphate                          | 78-40-0    |
| Tris(2-ethylhexyl) phosphate                | 78-42-2    |
| Tris(2-butoxyethyl) phosphate               | 78-51-3    |

## Appendix M: Per- and Polyfluoroalkyl Substances (PFAS)

| Per- and Polyfluoroalkyl Substances (PFAS) [14 items] | CAS No.    |
|---|------------|
| Perfluorobutyric acid                                 | 375-22-4   |
| Perfluoropentanoic acid                               | 2706-90-3  |
| Perfluorohexanoic acid                                | 307-24-4   |
| Perfluoroheptanoic acid                               | 375-85-9   |
| Perfluorononanoic acid                                | 375-95-1   |
| Perfluorodecanoic acid                                | 335-76-2   |
| Perfluorundecanoic acid                               | 2058-94-8  |
| Perfluorododecanoic acid                              | 307-55-1   |
| Perfluorotridecanoic acid                             | 72629-94-8 |
| Perfluorobutane sulfonic acid                         | 375-73-5   |
| Perfluoropentane sulfonic acid                        | 2706-91-4  |
| Perfluorohexane sulfonic acid                         | 355-46-4   |
| Perfluoroheptane sulfonic acid                        | 375-92-8   |
| Perfluorononane sulfonic acid                         | 68259-12-1 |

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