



# 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 Arsenic compounds	7440-38-2 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 12001-28-4 12001-29-5 12172-73-5 77536-66-4 77536-67-5 77536-68-6 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 Bedarfsgegenstände Verordnung GB 18401-2010, China 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 Beryllium compounds	7440-41-7 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 Apple Policy
		1000 ppm	All other materials, unless preapproved by Apple	Adhesives, plastics, epoxy resin	REACH 1907/2006 and amendments
Bromine Brominated compounds	7726-95-6 Several	900 ppm	All materials	Flame retardant, flux, solder paste	Apple Policy
		1500 ppm (Cl + Br)			

Chemical	CAS No.	Threshold	Scope	Examples	References
Cadmium Cadmium compounds	7440-43-9 Several	20 ppm	Battery cells and packs	Nickel cadmium battery	2013/56/EU IEEE 1680
		50 ppm	All other materials	Pigment stabilizer, copper alloys	2011/65/EU GB/T 26572 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 EPA, SNUR 2070-AJ73, Dec. 2014 IEEE 1680 Apple Policy
Chlorine Chlorinated compounds	7782-50-5 Several	Non-use; 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 UL 110 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 GB 18401-2003/2005, China GB 20400-2006, China
Halogenated Diphenyl Methanes	76253-60-6 81161-70-8 99688-47-8	1000 ppm and Br / Cl < 900 ppm	All materials	Capacitor, transformer	REACH 1907/2006 and amendments Apple Policy
Hexabromocyclododecane (HBCDD)	25637-99-4 3194-55-6 134237-50-6 134237-51-7 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 18540-29-9 7439-97-6 7439-92-1	100 ppm combined total	Packaging	Packaging materials	94/62/EC
Hexavalent Chromium (Cr(VI), Cr <sup>6+</sup> ) Hexavalent Chromium compounds	18540-29-9 Several	500 ppm	All materials	Metal coating, pigment	2011/65/EU GB/T 26572 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) EU Timber Regulation

Chemical	CAS No.	Threshold	Scope	Examples	References
Lead Lead compounds	7439-92-1 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 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 GB/T 26572 Taiwan BSMI RoHS
Mercury Mercury compounds	7439-97-6 Several	5 ppm	Battery cells and packs	Mercury oxide, zinc-manganese, alkaline manganese batteries	2013/56/EU
		1000 ppm Not intentionally added	All other materials	CCFL lamps, switches, dyes	2011/65/EU IEEE 1680 GB/T 26572 Taiwan BSMI RoHS
Methyl-phenol compounds	95-48-7 106-44-5 108-39-4 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 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 Apple Policy
Perchlorates	7601-89-0 7778-74-7 7790-98-9 7791-03-9 10034-81-8	0.1 ppm total content	All materials	Lithium perchlorate coin cell batteries	CA DTSC 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 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 REACH 1907/2006 and amendments 2011/65/EU

Chemical	CAS No.	Threshold	Scope	Examples	References
Polycyclic Aromatic Hydrocarbons (PAHs)	Appendix F	1 ppm individually 10 ppm for sum of total PAHs	External materials	Carbon black, plastics, dyes, combustion by-products	EC/1272/2013 Apple Policy
Polybrominated Biphenyls (PBB)	59536-65-1 Several	1000 ppm and Br < 900 ppm	All materials	Flame retardants	2011/65/EU GB/T 26572 Apple Policy
Polybrominated Diphenyl Ethers (PBDE)	1163-19-5 Several	1000 ppm and Br < 900 ppm	All materials	Flame retardants	2011/65/EU GB/T 26572 Apple Policy
Polychlorinated Biphenyl (PCB)	1336-36-3 Several	Non-detect (< 0.1 ppm)	All materials	Capacitor, transformer, heat transfer fluids, lubricants	2004/850/EU 85/467/EEC 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 REACH 1907/2006 and amendments 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 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 and amendments 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 Bisphenol S	620-92-8 2467-02-9 1333-16-0 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 <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 Cobalt Compounds	7440-48-4 Several	1000 ppm	Moisture indicator, additive in rubber, cobalt alloys	Reportable	REACH 1907/2006 and amendments 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 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 < 0.0002 mg/m <sup>3</sup>	Connector contacts, EMI finger (beryllium-copper alloys), transceivers (beryllium oxide)	California OSHA PEL (2006) 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 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 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 US EPA 3052 Others preapproved by Apple
Bromine (Br) Chlorine (Cl)	All materials except metals and ceramics	EN 14582 US EPA SW-846 5050/9056 Others preapproved by Apple
Cadmium (Cd) Hexavalent Chromium (Cr <sup>6+</sup> ) Lead (Pb) Mercury (Hg) Polybrominated biphenyl (PBB) Polybrominated diphenyl ether (PBDE) Bis(2-ethylhexyl) phthalate (DEHP) Butyl benzyl phthalate (BBP) Dibutyl phthalate (DBP) Diisobutyl phthalate (DIBP)	All materials. 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 Others preapproved by Apple
PFOS PFOA	Inks, paints, leather, textiles, and coatings	DIN CEN/TS 15968 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 5 ppm Minimum Detection Limit
Chlorinated Organic Solvents		EN 14582 for total chlorine 50 ppm Minimum Detection Limit Others preapproved by Apple
n-Hexane		Solvent extraction, analyzed by GC-MS or HPLC-MS 5 ppm Minimum Detection Limit
N-Methylpyrrolidone (NMP)		Solvent extraction, analyzed by GC-MS or HPLC-MS 5 ppm Minimum Detection Limit
n-Propyl Bromide (nPB)		EN 14582 for total bromine 50 ppm Minimum Detection Limit (EN 14582) Others preapproved by Apple
Toluene		Solvent extraction, analyzed by GC-MS or HPLC-MS 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-Diaminoaniline	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 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 68515-49-1
Diisononyl phthalate (DINP)	28553-12-0 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 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) 1,3,3-Trichloro-1,1-difluoropropane (HCFC-242fa)	134237-42-6 460-63-9
Dichlorotrifluoropropane (HCFC-243) 1,1-dichloro-1,2,2-trifluoropropane 2,3-dichloro-1,1,1-trifluoropropane 3,3-dichloro-1,1,1-trifluoropropane	134237-43-7 7125-99-7 338-75-0 460-69-5
Chlorotetrafluoropropane (HCFC-244) 3-Chloro-1,1,2,2-tetrafluoropropane (HCFC-244ca) 1-Chloro-1,1,2,2-tetrafluoropropane (HCFC-244cc)	134190-50-4 679-85-6 421-75-0
Trichlorofluoropropane (HCFC-251) 1,1,3-Trichloro-1-fluoropropane (HCFC-251fb) 1,1,2-Trichloro-1-fluoropropane (HCFC-251dc)	134190-51-5 818-99-5 421-41-0
Dichlorodifluoropropane (HCFC-252) 1,3-Dichloro-1,1-difluoropropane (HCFC-252fb)	134190-52-6 819-00-1
Chlorotrifluoropropane (HCFC-253) 3-chloro-1,1,1-trifluoropropane (HCFC-253fb)	134237-44-8 460-35-5
Dichlorofluoropropane (HCFC-261) 1,1-Dichloro-1-fluoropropane (HCFC-261fc) 1,2-Dichloro-2-fluoro-propane (HCFC-261ba)	134237-45-9 7799-56-6 420-97-3
Chlorodifluoropropane (HCFC-262) 1-Chloro-2,2-difluoropropane (HCFC-262ca) 2-Chloro-1,3-difluoropropane (HCFC-262da) 1-Chloro-1,1-difluoropropane (HCFC-262fc)	134190-53-7 420-99-5 102738-79-4 421-02-3
Chlorofluoropropane (HCFC-271) 2-Chloro-2-fluoropropane (HCFC-271ba) 1-Chloro-1-fluoropropane (HCFC-271fb)	134190-54-8 420-44-0 430-55-7

## 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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