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Taiwan's Persistent Organic Pollutant Management Strategy

1. Current Management Status

Taiwan strictly controls or prohibits the use of the first 12 types of persistent organic pollutants (POPs) currently regulated under the Stockholm Convention, and also prohibits or restricts the use of part of the nine new POPs regulated under the 2009 COP4 decisions; these chemical substances are Lindane, α-hexachlorocyclohexane, β-hexachlorocyclohexane, and pentabromodiphenyl ether. In addition, chlordecone and pentachlorobenzene have not been registered for use and pursuant to the Pesticide Management Act, "may not be imported, manufactured, sold, or used." Apart from legal and regulatory controls, the Taiwan Environmental Protection Administration (TEPA) has continued to conduct surveys of the dispersal of POPs in specific pollution sources and in the general environment during the past few years. Surveys of specific pollution sources have included dispersal surveys of air around the boundary of factories using toxic chemicals, testing of air, soil, and water within factories, and environmental testing of workers and laboratories. Surveys of the general environment have included environmental dispersal surveys of rivers, ports, reservoirs, and so forth.

The following is an overview of the current status on POP control in Taiwan and the results of ecological and environmental dispersal surveys performed in recent years.

1.1 Taiwan's relevant competent authorities manage POPs via laws and regulations under their jurisdiction. Furans and dioxin produced as byproducts of industrial processes or incineration are strictly controlled in accordance with relevant pollution control laws and regulations. The remaining chemical substances, polychlorinated biphenyls (PCBs), chlordane, dieldrin, DDT, toxaphene, endrin, heptachlor, aldrin, hexachlorobenzene, α-hexachlorocyclohexane, β-hexachlorocyclohexane, lindane, and pentabromodiphenyl ether are regulated

as toxic chemicals in accordance with the “Toxic Chemical Substances Control Act”, and, except for pentabromodiphenyl ether, which may still be used as a flame retardant, may not be manufactured, imported, sold, or used except for experimental, research, or educational purposes. Tables 1 and 2 show the current management status in Taiwan of 21 POPs listed under the Stockholm Convention.

Table 1 Current Management Status in Taiwan of the First 12 Chemicals Listed under the Stockholm Convention

No.	Chemical	Stockholm Convention	State of management in Taiwan
1	Polychlorinated biphenyls, PCBs	The use of PCBs is permitted prior to 2025 when no-leak conditions are met.	1. Manufacture, import, sale, and use prohibited since 1988. 2. The Toxic Chemical Substances Control Act announced full-scale prohibition of use starting in 2001. Capacitors and transformers containing 1,000 ppm PCBs must be immediately disposed of after end of use. 3. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
2	Chlordane	Use immediately prohibited	1. Use prohibited by the Toxic Chemical Substances Control Act in 1988. 2. Full-scale prohibition under the Environmental Agents Control Act in 1998. 3. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
3	Dieldrin	Use immediately prohibited	1. Use as a pesticide prohibited by the Pesticide Management Act in 1975. 2. Full-scale prohibition of use under the Toxic Chemical Substances Control Act starting in 1989. 3. Full-scale prohibition under the Environmental Agents Control Act in 1998. 4. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
4	DDT	Use prohibited, but permitted for disease control use	1. Use as a pesticide prohibited by the Pesticide Management Act in 1973. 2. Use prohibited by the Toxic Chemical Substances Control Act in 1989. 3. Full-scale prohibition under the Environmental Agents Control Act in 1998. 4. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
5	Toxaphene (Camphechlor)	Use immediately prohibited	1. Use as a pesticide prohibited by the Pesticide Management Act in 1983. 2. Use prohibited by the Toxic Chemical

			Substances Control Act in 1989. 3. Prohibition of use currently being announced pursuant to the Environmental Agents Control Act. 4. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
6	Endrin	Use immediately prohibited	1. Use as a pesticide prohibited by the Pesticide Management Act in 1971. 2. Full-scale prohibition of use under the Toxic Chemical Substances Control Act starting in 1989. 3. Prohibition of use is currently in effect pursuant to the Environmental Agents Control Act.
7	Heptachlor	Use immediately prohibited	1. Use as a pesticide prohibited by the Pesticide Management Act in 1975. 2. Full-scale prohibition of use under the Toxic Chemical Substances Control Act starting in 1989. 3. Full-scale prohibition under the Environmental Agents Control Act in 1998. 4. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
8	Aldrin	Use immediately prohibited	1. Use as a pesticide prohibited by the Pesticide Management Act in 1975. 2. Full-scale prohibition of use under the Toxic Chemical Substances Control Act starting in 1989.
9	Hexachlorobenzene, HCB	Use immediately prohibited	1. Use prohibited by the Toxic Chemical Substances Control Act in 1993. 2. Prohibition of use currently being announced pursuant to the Environmental Agents Control Act. 3. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
10	Mirex	Use immediately prohibited	1. Never registered for use in Taiwan. 2. Use prohibited under The Environmental Agents Control Act since 15th Sep. 2010. 3. Prohibition of use currently being announced pursuant to the Toxic Chemical Substances Control Act.

			4. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
11	Dioxins (Polychlorinated dibenzo-p-dioxins, PCDD)	Maximum effort must be made to reduce emissions	Emissions and concentration control standards are prescribed in the Air Pollution Control Act; Waste Disposal Act; and Soil and Groundwater Pollution Remediation Act, Drinking Water Management Statutes, and Environmental Agents Control Act.
12	Furans (Polychlorinated dibenzofurans, PCDF)	Maximum effort must be made to reduce emissions	

Table 2 Current Management Status in Taiwan of the 9 New Chemicals Listed under the Stockholm Convention

No.	Chemical	Stockholm Convention	State of management in Taiwan
1	Alpha hexachlorocyclohexane	Annex A[a]	1. Use prohibited by the Toxic Chemical Substances Control Act in 1989. 2. Use prohibited by the Environmental Agents Control Act. 3. Use as a pesticide prohibited by the Pesticide Management Act in 1975. 4. Control standards for livestock and poultry products on the market have been determined in accordance with the Standards for Pesticide Limits in Livestock and Poultry Products. 5. Control standards for agricultural products determined in accordance with Standards for Pesticides Residue Limits. 6. Pursuant to Article 11 of the Food Sanitation Management Act, foods or foods additives with residual pesticide concentrations exceeding the maximum safe permissible amount may not be manufactured, processed, blended, packaged, transported, stored, sold imported, exported, used as gifts, or publicly displayed. 7. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
2	Beta hexachlorocyclohexane	Annex A[a]	
3	Chlordecone	Annex A[a]	1. The agent Chlorodecone has not been registered in Taiwan for use as a pesticide, and in accordance with the Pesticide Management Act may not be manufactured, imported, sold, or used. 2. Control standards for agricultural products determined in accordance with Standards for Pesticides Residue Limits. 3. Use prohibited under the Environmental Agents Control Act since 15th Sep. 2010. 4. Prohibition of use currently being

No.	Chemical	Stockholm Convention	State of management in Taiwan
			announced pursuant to the Toxic Chemical Substances Control Act. 5. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
4	Lindane	Annex A[a]	1. Use prohibited by the Toxic Chemical Substances Control Act in 1989. 2. Use prohibited by the Environmental Agents Control Act. 3. Control standards have been determined in accordance with the Drinking Water Quality Standards, Effluent Standards, Surface Water Classification and Water Quality Standards, and Marine Environment Classification and Marine Environmental Quality Standards. 4. Use as a pesticide prohibited by the Pesticide Management Act in 1984. 5. Control standards for livestock and poultry products have been determined in accordance with the Standards for Pesticide Limits in Livestock and Poultry Products. 6. Control standards for agricultural products determined in accordance with Standards for Pesticides Residue Limits. 7. Pursuant to Article 11 of the Food Sanitation Management Act, foods or foods additives with residual pesticide concentrations exceeding the maximum safe permissible amount may not be manufactured, processed, blended, packaged, transported, stored, sold imported, exported, used as gifts, or publicly displayed. 8. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.

No.	Chemical		Stockholm Convention	State of management in Taiwan
5	C-pentaBDE (commercial pentabromo-diphenyl ether)	Tetrabromodiphenyl ether	Annex A[a]	When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
		Pentabromodiphenyl ether		1. Regulated under the Toxic Chemical Substances Control Act in 2005; may only be used as a flame retardant. 2. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
6	Pentachlorobenzene		Annex A and Annex C[a]	1. Not registered in Taiwan; and in accordance with the Pesticide Management Act may not be manufactured, imported, sold, or used. 2. Control standards for agricultural products determined in accordance with Standards for Pesticides Residue Limits. 3. Use prohibited under the Environmental Agents Control Act since 15th Sep. 2010. 4. Prohibition of use currently being announced pursuant to the Toxic Chemical Substances Control Act. 5. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
7	C-octaBDE (commercial octabromo-diphenyl ether)	Hexabromodiphenyl ether	Annex A[a]	1. Prohibition of use currently being announced pursuant to the Toxic Chemical Substances Control Act. 2. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
		Heptabromodiphenyl ether		
8	Hexabromobiphenyl		Annex A[a]	1. Prohibition of use currently being announced pursuant to the Toxic Chemical Substances Control Act. 2. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.
9	Perfluorooctane sulfonic acid, PFOS, its salts and perfluorooctane		Annex B[a,b]	1. Use prohibited under the Environmental Agents Control Act

No.	Chemical	Stockholm Convention	State of management in Taiwan
	sulfonyl fluoride, PFOS-F		Environmental Agents Control Act since 15th Sep. 2010. 2. Prohibition of use currently being announced pursuant to the Toxic Chemical Substances Control Act. 3. When disposed of, clean-up must comply with regulations governing hazardous industrial waste storage, clearance, and disposal.

[a]Annex A of the Stockholm Convention refers to substances that should be eliminated, while Annex B refers to substances that should be restricted.

[b]List of (a)Acceptable purposes**:**Photo-imaging, photo-resist and anti-reflective coatings for semi-conductor, etching agent for compound semi-conductor and ceramic filter, aviation hydraulic fluids, metal plating (hard metal plating) only in closed-loop systems, certain medical devices (such as ethylene tetrafluoroethylene copolymer (ETFE) layers and radio-opaque ETFE production, in vitro diagnostic medical devices, and CCD colour filters), fire extinguishing foam, insect baits for control of leaf-cutting ants from *Atta spp*. and *Acromyrmex spp*. And (b)Specific exemptions**:**Photo masks in the semiconductor and liquid crystal display (LCD) industries, metal plating (hard metal plating, decorative plating), electric and electronic parts for some colour printers and colour copy machines, insecticides for control of red imported fire ant, and termites, chemically driven oil production, carpets, leather and apparel, textiles and upholstery, paper and packaging, coatings and coating additives, rubber and plastics. for production and use of PFOS, its salts and PFOS-F

Table 3 Import and Export Data for Chemicals Regulated under the Stockholm Convention in 2002-2009

Chemicals	Import/ Export	Year								Total (Kg)
		2002	2003	2004	2005	2006	2007	2008	2009	
PCBs	Export	150	0	258	0	0	0	0	0	408
	Import	0	0	0	168	0	0	0	0	168
Chlordane	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Dieldrin	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
DDT	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Toxaphene	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Endrin	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Heptachlor	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Aldrin	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Hexachlorobenzene	Export	0	0	0	0	0	0	0		0
	Import	0	0	0	0	0	0	0		0
Mirex	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
Dioxin	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Furans	Export	0	0	0	0	0	0	0	0	0
	Import	12	11	210	112	3	0	176	596	524
Alpha hexachloro-cyclohexane	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Beta hexachloro-cyclohexane	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Lindane	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Chlordecone	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—

Chemicals	Import/ Export	Year								Total (Kg)
		2002	2003	2004	2005	2006	2007	2008	2009	
C-pentaBDE	Export	0	0	0	0	0	0	0	0	0
	Import	38,000	2,001	0	0	0	0	0	0	40,001
Pentachlorobenzene	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
C-octaBDE	Export	0	0	0	0	0	0	0	0	0
	Import	0	0	0	0	0	0	0	0	0
Hexabromobiphenyl	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—
PFOS, its salts and PFOS-F	Export	—	—	—	—	—	—	—	—	—
	Import	—	—	—	—	—	—	—	—	—

Source: ROC Directorate General of Customs (http://cus93.trade.gov.tw/fsci/)

1.2 The TEPA conducted environmental monitoring surveys of organochlorine pesticides in sediments from 30 rivers in Taiwan in 2002 to 2009, the results of which are shown in Table 4. These figures indicate that the average concentration of organochlorine pesticides in sediment samples was in the range of not-detected (ND) to 427 μg/kg dry weight, and the results of most tests was ND. This shows that the concentrations of toxic organochlorine compounds and their metabolites in river sediments are gradually falling below the detectable limit. In addition, environmental monitoring surveys of organochlorine pesticides in organism samples from 29 rivers and their estuaries were completed between 1999 and 2006. Environmental monitoring surveys of organochlorine pesticides in rivers were conducted in 2002, and the results showed that concentrations of organochlorine pesticides in most river samples are below the detectable limit, indicating that organochlorine pesticide concentrations in rivers are low

1.3 The TEPA performed environmental monitoring surveys of PCBs in 21 major rivers of Taiwan in 2002 and 2004, the results of which are shown in Tables 5 and 6. The average concentrations for 12 types of coplanar PCBs in river sediment samples were in the range of ND to 81 μg/kg dry weight, while total PCBs concentrations were in the range of ND to 184 μg/kg dry weight. These results indicate that the amount of PCBs in sediment samples have remained steady over the most recent five years, and PCBs concentrations are below the detectable limit for the vast majority of samples. Environmental coplanar PCBs test values have tended to be very low since the banning of PCBs under the Toxic Chemical Substance Control Act. The average concentrations for 12 types of coplanar PCBs in river organism samples (fish or shellfish tissue) were in the range of ND to 14 μg/kg dry weight, while total PCBs concentrations were in the range of ND to 63 μg/kg dry weight.

1.4 Mirex, Chlordecone, and Pentachlorobenzene are regulated by the Council of Agriculture under the “Pesticide Management Act”, and have not been approved for use in Taiwan.

1.5 Dioxin and furans are byproducts of industrial processes. The government has issued the "Waste Incinerator Dioxin Control and Emission Standards", "Medium and Small Waste Incinerator Dioxin Control and Emission Standards", "Steel Industry Electric Arc Furnace Dioxin Emission and Control Standards", "Steel Industry Sintering Plant Dioxin Control and Emission Standards", "Steel Industry Ash-collecting High-temperature Smelting Facility Dioxin Control and Emission Standards", and "Stationary Pollution Source Emission Standards" in order to effectively control dioxin emissions from all pollution sources. Dioxin emission control standards that have been issued in Taiwan are shown in Table 7. Twenty-four surveys of the dioxin concentration of environmental media (peripheral air, soil, and plants) around large incinerators had been performed by the end of 2009. The results of these surveys were compared with those of other countries, and no high concentrations were found. The results of dioxin surveys of the 24 incinerators are shown in Table 8.

Table 4 Organochlorine Pesticides in River Sediment, 2002-2009

River	Aldrin	Dieldrin	Endrin	DDT	Lindane	HCB	Heptachlor	Chlordane	Toxaphene
Year	2002-2003	2002-2003	2002-2003	2002-2003	2002-2003	2003	2003	2005-2007	2006-2009
Tamshui River	ND-3.6	ND-1.4	ND	ND	ND	—	—	ND-5.3	3.6-427
Nankan River	—	—	—	—	—	—	—	ND-<2.0	ND-16.6
Keya River	—	—	—	—	—	—	—	ND-<2.0	ND-159
Toucian River	ND-5.5	ND	ND	ND	ND	—	—	ND-<2.0	—
Houlong River	ND	ND-0.51	ND	ND-0.72	ND-0.43	ND-<0.2	ND	—	ND-<2.0
Jhonggang River	—	—	—	—	—	—	—	ND-<2.0	<2.0-8.0
Wu River	ND	ND-0.31	ND	ND-0.57	ND-0.45	ND-0.54	ND-0.88	—	ND-<2.0
Daan River	ND	ND-<0.2	ND	ND	ND-0.35	ND-0.57	ND	—	ND-<2.0
Dajia River	ND-6.5	ND	ND	ND	ND	—	—	ND-<2.0	—
Jhuoshuei River	ND-2.3	ND	ND	ND	ND	—	—	ND-<2.0	ND-3.7
Beigang River	ND-<0.2	ND-<0.2	ND	ND	ND-0.41	ND-0.36	ND	ND-<2.0	—
Puzih River	ND-1.8	ND	ND	ND	ND	—	—	ND	3.3-91.4
Bajhang River	ND	ND-1.3	ND	ND-0.27	ND-0.49	ND-1.3	ND	ND	ND-9.3
Jishuei River	ND	ND-0.42	ND-0.95	ND-0.44	ND-0.43	ND-0.83	ND	—	ND-<4.1
Zengwun River	ND-4.1	ND	ND	ND	ND-6.8	—	—	ND	ND-3.3
Jiangjyun River	—	—	—	—	—	—	—	ND	11.6-154
Yanshuei River	ND-1.6	ND-<0.2	ND-2.9	ND-1.2	ND-0.39	ND-0.46	ND-9.8	ND	ND-5.7
Erren River	ND-8.4	ND	ND	ND	ND-8.3	—	—	ND-5.2	<2.0-27.3
Dianbao River	—	—	—	—	—	—	—	ND-<2.0	8.1-89.1

River	Aldrin	Dieldrin	Endrin	DDT	Lindane	HCB	Heptachlor	Chlordane	Toxaphene
Year	2002-2003	2002-2003	2002-2003	2002-2003	2002-2003	2003	2003	2005-2007	2006-2009
Kaoping River	ND-3.5	ND-1.1	ND	ND	ND	—	—	ND	ND-57.9
Donggang River	ND-0.47	ND-0.45	ND-<0.2	ND-0.27	ND-0.46	ND-0.33	ND	ND-<2.0	<2.0-5.7
Linbian River	ND	ND-<0.2	ND	ND	ND-0.36	ND-<0.2	ND	ND	ND-3.6
Sincheng River	—	—	—	—	—	—	—	ND	ND-4.25
Lanyang River	ND-9.8	ND-1.0	ND	ND	ND	—	—	ND-<2.0	ND-6.4
Hualien River	ND-<0.2	ND-<0.2	ND	ND	ND-<0.2	ND-<0.2	ND	—	ND-<2.0
Siouguluan River	ND	ND-<0.2	ND	ND-<0.2	ND-0.44	ND-<0.2	ND	ND-<2.0	—
Beinan River	ND	ND-<0.2	ND	ND	ND-0.40	ND-<0.2	ND	—	ND-<2.0
Laojie River	—	—	—	—	—	—	—	—	<2.0-3.2
Love River	—	—	—	—	—	—	—	—	3.0-24.9
Sinhuwei River	—	—	—	—	—	—	—	—	<2.0-2.4
Total	0.59 (ND-9.8) N=174	<0.2 (ND-1.4) N=174	<0.2 (ND-2.9) N=174	<0.2 (ND-1.2) N=174	<0.2 (ND-8.3) N=174	<0.2 (ND-1.3) N=120	0.20 (ND-9.8) N=120	<2.0 (ND-5.3) N=147	16.5 (ND-427) N=159

Concentration units: μg/kg dry weight

Table 5 Total Amount of PCBs in 21 Major Rivers in Taiwan

Year	Sediment (μg/kg dry weight)		Water (μg/L)		Fish (μg/kg wet weight)	
	Total Amount of 12 coplanar PCBs [a]	Total Amount of 25 common PCBs [b]	Total Amount of 12 coplanar PCBs	Total Amount of 25 common PCBs	Total Amount of 12 coplanar PCBs	Total Amount of 25 common PCBs
2002 (9 rivers)	<0.5 (ND-4.7) N=54	1.1 (ND-32) N=54	ND (ND-0.0037) N=36	ND N=36	0.07 (ND-1.3) N=18	4.8 (ND-23) N=18
2004 (12 rivers)	1.7 (ND-81) N=72	6.9 (ND-184) N=72	—	—	1.9 (ND-14) N=26	10 (ND-63) N=26

Table 6 PCBs concentrations in 21 Major Rivers in Taiwan

River	Year	Sediment (μg/kg dry weight)		Water (μg/L)		Fish (μg/kg wet weight)	
		Total Amount of 12 coplanar PCBs [a]	Total Amount of 25 common PCBs [b]	Total Amount of 12 coplanar PCBs	Total Amount of 25 common PCBs	Total Amount of 12 coplanar PCBs	Total Amount of 25 common PCBs
Tamshui River	2002	ND-<0.5	ND-5.6	ND	ND	ND-1.3	ND-23
Toucian River	2002	ND	ND-0.9	ND	ND	ND	ND-1.3
Houlong River	2004	ND-3.1	ND-16	—	—	ND-13	ND-20
Daan River	2004	ND-2.2	ND-10	—	—	0.8	12
Dajia River	2002	ND	ND-2.0	ND	ND	ND	ND-8.4
Wu River	2004	ND-1.5	ND-21	—	—	ND-14	ND-63
Jhuoshuei River	2002	ND	ND-1.8	ND	ND	—	—
Beigang River	2004	ND-1.5	ND-5.3	—	—	ND-1.6	ND-23
Puzih River	2002	ND	ND-2.0	ND	ND	ND	ND-6.3
Bajhang River	2004	ND-0.2	ND-6.9	—	—	ND-0.8	ND-13
Jishuei River	2004	ND-1.0	ND-2.0	—	—	ND-0.8	ND-17
Zengwun River	2002	ND	ND-1.2	ND	ND	ND	ND
Yanshuei River	2004	ND-2.5	ND-28	—	—	ND-1.4	ND-3.0
Erren River	2002	ND-4.7	ND-32.1	ND-0.0037	ND	—	—
Kaoping River	2002	ND	ND	ND	ND	ND	ND-21
Donggang River	2004	ND-81	ND-184	—	—	ND-4.5	ND-21
Linbian River	2004	ND-0.8	ND-5.7	—	—	ND-2.7	ND-17
Lanyang River	2002	ND	ND-0.7	ND	ND	ND	ND-8.1
Hualien River	2004	ND-1.3	ND-11	—	—	ND-<0.4	ND-3.6
Siouguluan River	2004	ND-1.0	ND-25	—	—	ND	6.1
Beinan River	2004	ND-0.5	ND-19	—	—	ND-<0.4	ND-11
Total	2002, 2004	1.0 (ND-81) N=126	4.5 (ND-184) N=126	ND (ND-0.0037) N=36	ND N=36	1.2 (ND-14) N=44	8.3 (ND-63) N=44

[a] Total Amount of 12 types of homologous coplanar PCBs, including IUPAC number 77, 81, 105, 114, 118, 123, 126, 156, 157, 167, 169, 189.

[b] Total Amount of 25 common homologous PCBs, including IUPAC number 8, 28, 37, 44, 49, 52, 60, 66, 67, 70, 74, 82, 81, 99, 101, 110, 128, 138, 153, 158, 166, 170, 179, 180, 183.

Table 7 Dioxin Emission Control Standards in Taiwan

Target	Condition	Emission control standard ($ngI\text{-}TEQ/Nm^3$)	Implementation date	
Waste incinerators	10 ton/hr or above 300 ton/day	0.1	New	1997/8/8
			Existing	2001/8/8
Medium and small waste incinerators	Above 4 ton/hr	0.1	New	2001/1/1
			Existing	2003/1/1
	Above 4 ton/hr	0.5	New	2001/1/1
			Existing	2004/1/1
Steel industry electric arc furnaces	New	0.5	2002/1/1	
	Existing	5.0	2004/1/1	
		0.5	2007/1/1	
Steel industry sintering plants	New	0.5	2004/6/16	
	Existing	2.0	2006/1/1	
		1.09	2008/1/1	
Steel industry ash-collecting high-temperature smelting facilities	New	0.4	2005/10/12	
	Existing	9	2005/10/12	
		1	2006/9/1	
Stationary pollution sources	New	0.5	2006/1/2	
	Existing	2.0	2007/1/1	
		1.0	2008/1/1	

※ I-TEQ：International Toxic Equivalent

Table 8 Current Dioxin Concentrations around 24 Large Incinerators in Taiwan

Environmental medium	Surveys around 24 large incinerators in Taiwan	Other countries
Ambient air concentration	0.0044 –2.93 ($pg\ WHO\text{-}TEQ/m^3$)	0.010-1.8 (pg WHO-TEQ/g)
Plant concentration	0.077 –21.0 (pg WHO-TEQ/g)	0.62 –71.4 (pg WHO-TEQ/g)
Soil concentration	0.003 –73.3 (pg WHO-TEQ/g)	0.00067 –110 (pg WHO-TEQ/g)

※ WHO-TEQ：Toxic Equivalent of WHO

1.6 Pentabromodiphenyl ether was promulgated as a toxic chemical substance on December 30, 2005 to be controlled strictly. Environmental monitoring surveys of polybrominated diphenyl ethers (PBDEs) in rivers were performed from 2004 to 2009, the results of which are shown in Table 9. PBDEs concentration data had accumulated for fish samples and sediment samples for 15 rivers (sampling from each river in two different years) over the period of 2004-2009. Apart from three rivers (Daan River, Wu River, and Jhuoshuei River), which had higher total PBDEs concentrations in sediment, all other rivers had lower values during the second year.

Table 9 PBDEs Concentration in River Sediment, 2004-2009

Year	Average concentration during the dry season (μg/kg dry weight)	Average concentration during the rainy season (μg/kg dry weight)
2004 (12 rivers，N＝72)	0.933-43.2	1.92-46.3
2005 (8 rivers，N＝56)	0.545-25.7	0.147-26.6
2006 (8 rivers，N＝41)	0.163-35.3	1.17-57.6
2007 (8 rivers，N＝49)	0.784-52.3	0.574-58.9
2008 (6 rivers，N＝36)	0.263-24.4	0.23-13.8
2009 (5 rivers，N＝32)	7.37-162	0.574-326

1.7 Although the use of perfluorooctane sulfonic acid (PFOS) is currently banned under the Environmental Agents Control Act and the Toxic Chemical Substances Control Act, the TEPA has already begun monitoring this substance. A 2006 survey of the Dahan River, Keelung River, Keya River (including Sansinggong River), and Jiangjyun River showed an average PFOS concentration of 1.20 μg/L (n=38) in water samples. A 2007 survey of the Nankan River, Jhonggang River, Fongshan River, Ji-an River, Sindian River, Jingmei River, and Tamshui River showed an average PFOS concentration of 0.10 μg/L (n=64). A 2008 survey of the Laojie River, Dongshan River, Wu River, Houjin River, Erren River, Niouchou River, Dahan River, and

Keelung River showed an average PFOS concentration of 0.014 μg/L (n=54). A 2009 survey of 30 water samples from 7 rivers showed an average PFOS concentration of 0.00616μg/L (n=30) (see Table 10).

Table 10　PFOS Concentrations in Water Samples of Rivers, 2006-2009

Year	Average concentration in water samples(μg/L)
2006 （4 rivers，N＝38）	1.22
2007 （7 rivers，N＝64）	0.100
2008 （8 rivers，N＝54）	0.014
2009 （7 rivers，N＝30）	0.00616

2. POPs Management Strategies in Taiwan

The management of POPs touches on issues that are wide-ranging and complex. Taiwan will continue to improve environmental pollutant handling mechanisms, pollutant dispersal monitoring, risk management functions, and the skills of professional manpower in order to effectively alleviate environmental pollution problems and strengthen control of pollutants.

The government formulated the Three-year Environmental Protection Administrative Action Plan in 2004 in accordance with the Fundamental Environmental Protection Act and the National Environmental Protection Plan. The Action Plan uses the three tools of environmental education, environmental harmonization, and preventive incentives, and incorporates the regulatory content of the Stockholm Convention. From 2005 to the present, the TEPA has participated in the annual Conference of the Parties (COP) of the Stockholm Convention and Persistent Organic Pollutants Review Conference (POPRC) in order to keep up with Stockholm Convention development trends. Although Taiwan is not a party to the convention, it is still necessary to draft implementation plans and stay in harmony with international norms. As a consequence, the TEPA approved The National Implementation Plan of Republic of China (R.O.C.,Taiwan) under the Stockholm Convention on POPs (NIP) on July 3, 2008, although at that time Taiwan's NIP chiefly covered the first 12 POPs

specified at the Stockholm Convention. After the 4th Conference of the Parties (COP4) added 9 new chemical substances on May 4, 2009, the TEPA responded by drafting the The National Implementation Plan of Republic of China (R.O.C.,Taiwan) under the Stockholm Convention on POPs (2010 Revised Version) on May 7, 2010 to serve as a basis for domestic POPs control work. The following is an overview of Taiwan's POPs management strategies:

2.1 Keeping up with Stockholm Convention Development Trends; Adjusting Taiwan's Control Methods Concurrently with International Changes

Taiwan will formulate the prohibition and control of the production and use of pollutants regulated by the Stockholm Convention concurrently with Convention members. Beyond continuing to collect the most up-to-date international control trends and information, the government will also consider controlling substances added to the list of items regulated by the Convention. Substances may be listed for regulatory control under the Toxic Chemical Substances Control Act when their toxicological characteristics are consistent with the TEPA's "Operating Principles for Identification of Toxic Chemicals" and they are confirmed as being hazardous. The government thereby hopes to prevent toxic substances from affecting human health and ecological systems via the food chain. In order to fulfill the Convention's requirements and realize long-term human and environmental health in Taiwan, the government will actively seek out the cooperation of administrative agencies and industrial enterprises, and will implement management of chemical products via administrative agencies. Enterprises will be expected to seek out optimal alternative products and use the best available technology (BAT) to perform release management, ensuring that POPs' influence on the environment and human health will be minimized.

2.2 Implementing Pollution Source Reduction Plans for Dioxin; Reducing Environmental Pollution Load

Taiwan considers the reduction of environmental pollution to be an extremely important task. For instance, addressing the need to reduce the toxic pollutants dioxin and heavy metals, the TEPA will establish an air pollutant emission database for incinerators, sintering furnaces, and electric arc furnaces, and perform emissions reduction work. The

TEPA will also conduct surveys concerning the reduction, recycling, and characteristics of incinerator ash and other wastes, and determine overall management methods and treatment system implementation programs in order to gradually strengthen holistic pollution reduction efforts.

2.3 Continuing Implementating of Environmental Dispersal Surveys; Strengthening the Sharing, Application and Awareness of Information

Taiwan will continue to monitor POPs and perform environmental background dispersal surveys of air, soil, river sediments, and fish. The government has already established an ultra-micro analysis laboratory capable of meeting international analytical standards for dioxin and some POPs. In addition, Taiwan's environmental protection agencies are paying close attention to international POPs monitoring, testing, and control trends, keeping tabs on the newest information and data, and regularly publishing Taiwan's environmental background survey data, boosting awareness, and working to ease public concerns.

2.5 Strengthening Coordination between Responsible Agencies; Establishing Integrated Crisis Response Mechanisms

POPs must be adequately managed at the level of source, transmission pathway, and hazard in order to lessen their threat to the environment and human body. The TEPA will continue to work in close coordination with the Department of Health and Council of Agriculture, and will employ interagency coordination mechanisms to quickly and effectively eliminate environmental pollution and food safety problems of public concern as soon as they occur.

2.6 Continuing Amending the Laws and Regulations of Hazardous Industrial Waste Concerning POPs

The December 14, 2006 revision of the Standards for Defining Hazardous Industrial Waste designated 17 compounds found in industrial waste with total toxic equivalent quantities exceeding 1.0 ng I-TEQ/g, including 2,3,7,8-TCDD and TCDF as dioxin-containing hazardous industrial waste.

3. *Conclusions*

Although not being a signatory to the Stockholm Convention, in order to demonstrate that Taiwan is willing and able to actively protect the world's environment, Taiwan has drafted a national implementation plan for the management of POPs, and will abide by the Convention's various control timetables and tasks, and prepare national reports for submission to the UN Secretariat. Taiwan will also participate actively in international organizations, NGOs, and Convention signatory conferences, and will quickly adopt necessary measures in response to international convention trends. Apart from adjusting domestic control methods in line with international changes, Taiwan will continue to implement reduction plans for dioxin and other pollutants in order to lessen the environmental pollution load. Taiwan will further strengthen liaison and coordination between responsible agencies, establish integrated crisis response mechanisms, and promote information sharing and awareness. The TEPA will continue to perform POPs environmental background surveys on an annual basis in order to guide control strategies and provide early warning of problems.