Government of Japan

Dioxins

2009

Preface

Dioxins are substances not manufactured industrially. They are formed unintentionally, most often during the course of incineration. This explains why these substances are ubiquitous in the environment, although in very small in quantities.

The level of exposure to dioxins in everyday life in Japan does not lead to health effects, however, the public still have questions and express concerns. To address these concerns, ministries and agencies that are members of the Council of Inter-Ministries and Agencies on Dioxin Policy collaborated to produce this pamphlet.

Due to nationwide efforts to tackle the dioxin issue, national dioxin emissions in 2004 has been reduced by approximately 96 % from the 1997 level. Accordingly, environmental levels of dioxins almost achieve environmental quality standards.

This pamphlet explains in plain terms the nature of dioxins and how they are formed, and introduces concisely the actions of the Government in establishing a Council of Ministries and Agencies on Dioxin Policy and working in a unified way to promote dioxin counter-measures. We sincerely hope that this pamphlet will promote public understanding about dioxins.

Council of Inter-Ministries and Agencies on Dioxin Policy: Member Ministries and Agencies, Government of Japan

Cabinet Office
National Police Agency
Ministry of Internal Affairs and Communications
Ministry of Foreign Affairs
Ministry of Education, Culture, Sports, Science and Technology
Ministry of Health, Labour and Welfare
Ministry of Agriculture, Forestry and Fisheries
Ministry of Economy, Trade and Industry
Ministry of Land, Infrastructure and Transport
Ministry of the Environment

Contents

1 What are dioxins?

1 The term "dioxins" refers to PCDDs, PCDFs and co-planar PCBs.

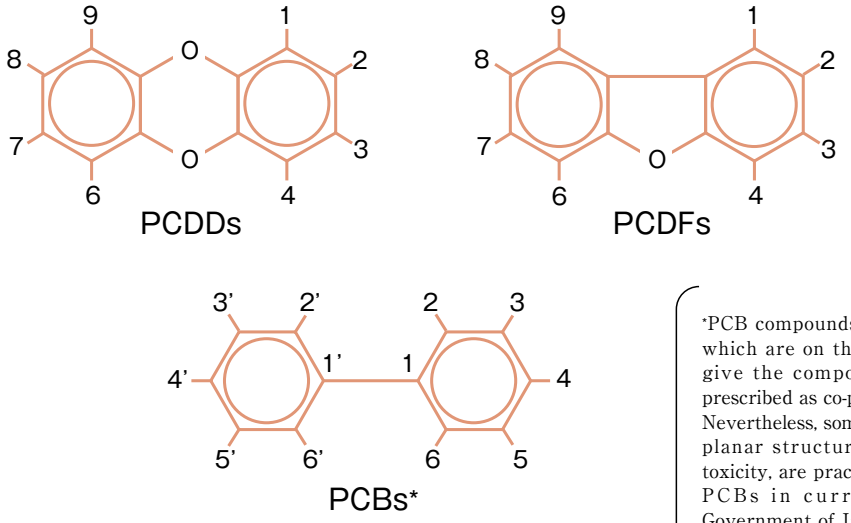
Polychlorinated Dibenzo-p-Dioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) are collectively called dioxins. Co-planar Polychlorinated Biphenyls (co-planar PCBs or dioxin-like PCBs) possess toxicity similar to that of dioxins and are called dioxin-like compounds.

"Dioxins" are defined to include PCDDs, PCDFs and co-planar PCBs in the Law Concerning Special Measures against Dioxins (the Dioxins Law) promulgated on July 16, 1999.

Accordingly, throughout this pamphlet, the term "dioxins" will be used to refer to PCDDs, PCDFs and co-planar PCBs.

The general structure of a dioxin molecule is two rings of six carbon atoms (benzene rings, shown as in Fig. 1) bound by oxygen atom(s) (shown as O in Fig. 1) with chlorine or hydrogen atoms attached (the numbered positions: 1-9 and 2′-6′ in Fig. 1). There are 75 kinds of PCDDs, 135 PCDFs and more than 10 co-planar PCBs, with the shape of the molecule depending on the numbers and locations of the chlorine atoms (Among dioxins, 29 congeners are thought to have some toxicities).

Figure 1 Chemical Structure of Dioxins



*PCB compounds, the two benzene rings of which are on the same plane, and thereby give the compound a flat structure, are prescribed as co-planar PCBs.
Nevertheless, some PCBs that do not have the planar structure, but possess dioxin-like toxicity, are practically classified as co-planar PCBs in current documents of the Government of Japan (See Table 1 on page 2 for details.).

2 Toxicity of dioxins overall is expressed as Toxic Equivalents (TEQs).

The degree of toxicity of dioxins varies from compound to compound. Among all dioxins, the tetrachlorinated dibenzo-p-dioxin with chlorine atoms attached in the 2, 3, 7 and 8 positions (2,3,7,8-TeCDD) is known to possess the highest toxic potency.

In order to assess the toxicity of dioxins overall, a way is needed to consider their aggregate effects.

The method used here is to assign an individual Toxic Equivalency Factor (TEF) value to each dioxin compound. TEFs are estimates of the toxicity of dioxins relative to the toxicity of 2,3,7,8-TeCDD, which is assigned a TEF of 1. In many studies and monitoring results, amounts or concentrations of dioxins are presented as Toxic Equivalents (TEQs), which are determined by summing the products that result from multiplying concentrations of individual dioxin compound by the corresponding TEF (See Table 1). Concentration, etc. of dioxins is presented as TEQ in this pamphlet. TEFs were revised in 2006 by WHO (World Health Organization).

Table 1 Toxic Equivalency Factors (TEFs)*

	Name of Compound	TEF value *1 (WHO 1998 TEF)	TEF value *2 (WHO 2005 TEF)
PCDDs (Polychlorinated dibenzo-p-dioxins)	2,3,7,8-TeCDD	1	1
	1,2,3,7,8-PeCDD	1	1
	1,2,3,4,7,8-HxCDD	0.1	0.1
	1,2,3,6,7,8-HxCDD	0.1	0.1
	1,2,3,7,8,9-HxCDD	0.1	0.1
	1,2,3,4,6,7,8-HpCDD	0.01	0.01
	OCDD	0.0001	0.0003
PCDFs (Polychlorinated dibenzofurans)	2,3,7,8-TeCDF	0.1	0.1
	1,2,3,7,8-PeCDF	0.05	0.03
	2,3,4,7,8-PeCDF	0.5	0.3
	1,2,3,4,7,8-HxCDF	0.1	0.1
	1,2,3,6,7,8-HxCDF	0.1	0.1
	1,2,3,7,8,9-HxCDF	0.1	0.1
	2,3,4,6,7,8-HxCDF	0.1	0.1
	1,2,3,4,6,7,8-HpCDF	0.01	0.01
	1,2,3,4,7,8,9-HpCDF	0.01	0.01
	OCDF	0.0001	0.0003
Co-planar PCBs	3,4,4',5-TCB	0.0001	0.0003
	3,3',4,4'-TCB	0.0001	0.0001
	3,3',4,4',5-PeCB	0.1	0.1
	3,3',4,4',5,5'-HxCB	0.01	0.03
	2,3,3',4,4'-PeCB	0.0001	0.00003
	2,3,4,4',5-PeCB	0.0005	0.00003
	2,3',4,4',5PeCB	0.0001	0.00003
	2',3,4,4',5-PeCB	0.0001	0.00003
	2,3,3',4,4',5-HxCB	0.0005	0.00003
	2,3,3',4,4',5'-HxCB	0.0005	0.00003
	2,3',4,4',5,5'-HxCB	0.00001	0.00003
	2,3,3',4,4',5,5'-HpCB	0.0001	0.00003

*1:Proposed at the WHO meeting in 1997 and published in an academic journal in 1998.
*2:Proposed at the WHO meeting in 2005 and published in an academic journal in 2006.

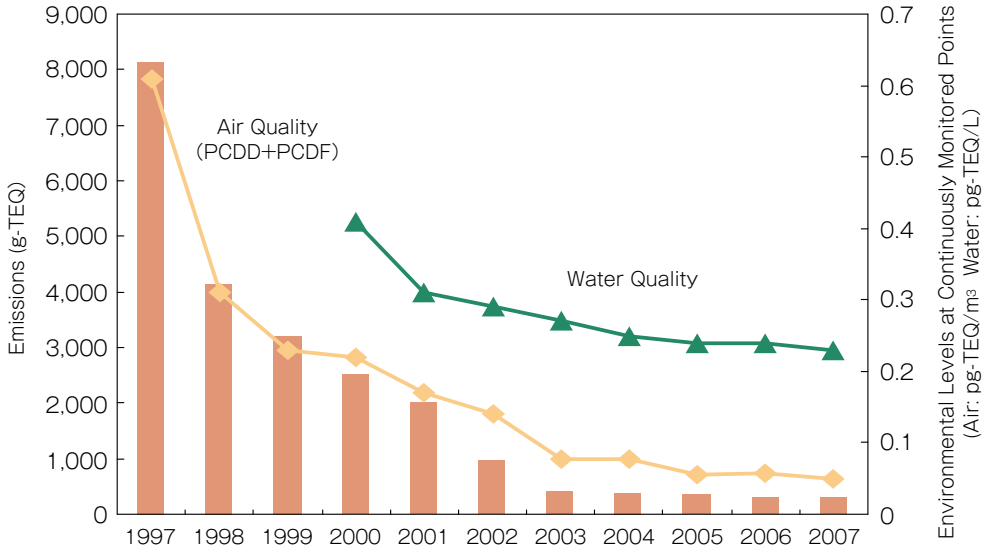
3 Dioxins have no color and very low water solubility.

Dioxins in general are colorless solids with very low water solubility and low vapor pressure properties. On the other hand, dioxins characteristically exhibit a high degree of solubility in fats and oils. They are generally stable, not reacting easily to other chemical substances, acids and alkalis, but are thought to gradually decompose in the presence of solar ultraviolet light.

4 Dioxins are formed as unintended by-products in waste incineration and other various processes.

Dioxins are not produced intentionally, other than for research purposes, such as preparing standard material for analysis. Dioxins are by-products generated from processes when heat is applied to substances containing carbon, oxygen, hydrogen and chlorine.

Figure 2 National Dioxin Emissions and Environmental Levels in Air and Water



The major source of dioxins at present is waste incineration, with most being formed in combustion processes and emitted to the ambient air without being fully captured by waste-gas treatment equipment. Other sources exist, such as emissions from electric steel-making furnaces, cigarette smoke, and automobile exhaust. Some reports indicate that dioxins may have accumulated in bottom sediment in the environment due to the past use of PCBs and some types of agricultural chemicals, which contained dioxins as impurities.

The behavior of dioxins in the environment is not fully known. Taking the atmospheric pathway, for example, dioxins in the air are associated with particulate matter and fall to the ground, contaminating soil and water. It is thought that over long periods of time these dioxins, together with those emitted into the environment via various other pathways, ultimately accumulate in aquatic sediments and enter the food chain when ingested by plankton and fish, thereby starting to concentrate in organisms.

The national total amount of dioxin emissions in Japan in 2007 is estimated to have been between approximately 286 and 307 g-TEQ (See Table 2 for details).

Natural sources of dioxins are thought to exist. Forest fires and volcanic activities, for example, are said to produce dioxins.

In coming years, it will be important to get a better grasp of the status of dioxin emissions.

Table 2 National Dioxins Emissions Inventory

WHO-TEF(1998)

Sources of Dioxin Emissions	Total Amount of Dioxins Emissions (g-TEQ/year)										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1.Fields of waster disposal	7,205 ~ 7,658	3,355 ~ 3,808	2,562 ~ 2,893	2,121 ~ 2,252	1,689 ~ 1,801	748 ~ 771	219 ~ 244	215 ~ 237	213 ~ 237	193 ~ 218	182 ~ 200
"Water"	5.3	5.3	5.3	2.5	1.5	0.87	0.60	0.65	0.36	0.78	1.6
General waste incinerators	5,000	1,550	1,350	1,019	812	370	71	64	62	54	52
"Water"	0.044	0.044	0.035	0.035	0.019	0.008	0.004	0.002	0.001	0.003	0.002
Industrial waste incinerators	1,505	1,105	695	558	535	266	75	70	73	63	60
"Water"	5.3	5.3	5.3	2.5	1.5	0.86	0.60	0.65	0.36	0.78	1.6
Small-scale waste incinerators	700 ~ 1,153	700 ~ 1,153	517 ~ 848	544 ~ 675	342 ~ 454	112 ~ 135	73 ~ 98	81 ~ 103	78 ~ 102	76 ~ 101	70 ~ 88
2.Fields of industry	470	335	306	268	205	189	149	125	110	93	100
"Water"	6.3	5.8	5.8	5.0	1.8	1.2	0.93	1.0	1.0	0.75	0.8
Electric steel-making furnaces	229	140	142	131	95.3	94.8	80.3	64.0	49.6	39.5	50.2
Sintering facilities for steel industry	135	114	101	69.8	65.0	51.1	35.7	30.4	29.3	21.2	20.5
Facilities for recovering zinc	47.4	25.4	21.8	26.5	9.2	14.7	5.5	8.1	4.1	8.2	1.8
"Water"	0.0036	0.0036	0.0036	0.0036	0.0036	0.0026	0.0066	0.0047	0.0018	0.00065	0.0014
Facilities for manufacturing	31.0	28.8	23.1	22.2	19.7	16.3	17.4	13.0	15.2	12.9	15.6
"Water"	0.34	0.068	0.093	0.056	0.082	0.024	0.029	0.011	0.008	0.027	0.023
Facilities for recovering copper	0.053	0.053	0.048	0.038	0.013	0.088	–	–	–	–	–
Pulping process with bleaching	0.74	0.71	0.74	0.73	0.90	0.65	0.46	0.62	0.58	0.50	0.58
"Water"	0.74	0.71	0.74	0.73	0.90	0.65	0.46	0.62	0.58	0.50	0.58
Other facilities	26.5	25.6	17.8	17.9	15.3	11.0	9.9	9.1	10.8	10.2	11.1
"Water"	5.2	5.0	5.0	4.2	0.85	0.52	0.44	0.38	0.42	0.22	0.19
3.Others	4.8 ~ 7.4	4.9 ~ 7.6	4.9 ~ 7.7	4.9 ~ 7.6	4.7 ~ 7.5	4.3 ~ 7.2	4.4 ~ 7.3	4.2 ~ 7.2	4.2 ~ 7.2	4.0 ~ 7.0	4.2 ~ 7.3
"Water"	1.2	1.2	1.2	1.2	1.0	0.53	0.56	0.37	0.47	0.24	0.29
Crematories	2.1 ~ 4.6	2.2 ~ 4.8	2.2 ~ 4.9	2.2 ~ 4.8	2.2 ~ 4.9	2.3 ~ 5.1	2.3 ~ 5.1	2.4 ~ 5.3	2.4 ~ 5.3	2.5 ~ 5.4	2.6 ~ 5.7
Cigarette smoke	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1 ~ 0.2	0.1
Automobile exhaust	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.2	1.2
Sewage treatment plants	1.1	1.1	1.1	1.1	0.99	0.51	0.54	0.36	0.46	0.23	0.28
"Water"	1.1	1.1	1.1	1.1	0.99	0.51	0.54	0.36	0.46	0.23	0.28
Solid waste final disposal sites	0.093	0.093	0.093	0.056	0.027	0.021	0.020	0.018	0.012	0.014	0.010
"Water"	0.093	0.093	0.093	0.056	0.027	0.021	0.020	0.018	0.012	0.014	0.010
Total	7,680 ~ 8,135	3,695 ~ 4,151	2,874 ~ 3,208	2,394 ~ 2,527	1,899 ~ 2,013	941 ~ 967	372 ~ 400	344 ~ 369	327 ~ 354	289 ~ 317	286 ~ 307
"Water"	12.8	12.3	12.4	8.7	4.4	2.6	2.1	2.0	1.8	1.8	2.7

Note:"Water" in the table means amount emitted into water.

2 What are the risks of dioxins to humans?

1 Exposure to dioxins in everyday life is not high enough to result in acute toxicity.

It is said that dioxins are "more toxic than cyanide and the most toxic of man-made chemicals." The toxicity referred to, however, is the acute toxicity that occurs from very high levels of exposure, such as ingesting at one time a dose of some hundred thousand times the regular daily intake.

Since dioxins are not formed intentionally and the amount present in the environment or in food is extremely small, the regular levels of daily intake are very unlikely to lead to acute toxicity.

2 Although the dioxin 2,3,7,8-TeCDD has been recognized as carcinogenic, the current level of contamination in the environment in Japan is below the cancer risk level.

The International Agency for Research on Cancer (IARC) under the World Health Organization (WHO) identified 2,3,7,8-TeCDD as the most toxic of all dioxin compounds, and as carcinogenic to humans based mostly on the studies involving accidental heavy exposure. However, the carcinogenicity of dioxins is relatively weak, caused not by direct damage to genes, but rather it is thought to be due to their promotional activities on the initiated cells by other possible carcinogens.

It should be noted that the present levels of dioxins in the environment in Japan pose almost no cancer risk.

3 High-level exposures to dioxins are reported to cause cancer and to affect reproductive, thyroid and immune functions in experiments in animals. However, evidence relating to humans is not adequately available.

Dioxins are reported to cause cancer and malfunctions in thyroid glands, atrophy of gonads, reductions in the sperm production, and suppression of the immune system.

However, since effects on humans are not clear at present, further studies are needed of the impacts on human health.

4 Tolerable Daily Intake (TDI) is used as the indicator for evaluating safety of exposure to dioxins.

The Tolerable Daily Intake (TDI) is the amount of intake per kg of body weight per day of a chemical substance suspected of having adverse health effects, when absorbed into the body over a long period of time. The TDI is judged not to give rise to manifestations of health effects if such an amount is taken every day for an entire lifetime. The TDI of dioxins in Japan was established at 4 pg-TEQ/kg/day in June 1999 based on the latest available scientific information.

Safety of the total amount of dioxins ingested by humans is assessed corresponding to this value.

Brominated Dioxins

The brominated dioxin molecule has the chemical structure with bromine atoms attached to the numbered positions (1-9, 2′ -6′) in Fig. 1 (also includes those with chlorine atoms attached). According to the survey conducted by international institutions and other organizations, brominated dioxins are formed when burning plastic containing bromine flame retardant. However, it calls for further research on such subject as its sources.

The Impact of brominated dioxins on human health or the ecosystem is not known in detail. Therefore, the Ministry of the Environment is promoting research on brominated dioxins by gathering and sorting information on toxicity, exposed conditions and an analysis method while monitoring brominated dioxins in waste gas and water.

Tolerable Daily Intake (TDI) of Dioxins

The Environmental Health Committee of the Central Environment Council of the Environment Agency (former Ministry of the Environment), and the Food Sanitation Investigation Council and Living Environment Council of the Ministry of Health and Welfare (former Ministry of Health, Labour and Welfare) jointly discussed the TDI based on scientific grounds, and completed a report on the topic on June 21, 1999. The report was acknowledged at the meeting of Ministerial Council on Dioxin Policy on the 25th of the same month.

The main points of the report are summarized below:

The TDI of dioxins (PCDDs and PCDFs, including co-planar PCBs) is established at 4 pg-TEQ/kg/day (4 pg per day for each kg of body weight).

Since subtle effects have been observed in some animal tests at body burden levels below those of the evidence employed in estimation of the TDI value, it is important to promote further research.

TDI is a value calculated as an index of the effects on health when daily intake continues throughout one's life. A temporary slight excess of intake over the TDI does not necessarily mean damage to health.

The TDI is established based upon effects due to exposure during the fetal period which is the most sensitive period. Manifestation of effects such as carcinogenicity would only occur as a result of higher exposure than the established TDI.

TDI value of 4 pg-TEQ/kg/day is determined by extrapolating results of animal tests for humans, multiplied by a factor of 0.1 for taking account of uncertainty.

Units for Extremely Small Quantities

Units for measuring weight

kg	(kilogram)		
g	(gram)		
mg	(milligram)	$=10^{-3}$ g	(thousandth of a gram)
μg	(microgram)	$=10^{-6}$ g	(millionth of a gram)
ng	(nanogram)	$=10^{-9}$ g	(billionth of a gram)
pg	(picogram)	$=10^{-12}$ g	(trillionth of a gram)

If water were held in a container the size of Tokyo Dome baseball stadium, it would weigh about 10^{12} g. Suppose a lump of sugar (1g) were dissolved in the water, the result would be 1 pg of sugar in each gram of water.

3 How large is the impact of dioxins on the environment?

1 Dioxin levels in the environment in Japan almost achieve environmental quality standards.

Based on the Dioxins Law, local public authorities are monitoring dioxin levels in air, water (including the sediment at the bottom) and soil in order to grasp the actual conditions of dioxin pollution throughout Japan. The Fiscal Year (FY) 2007 monitoring results show that average dioxin concentrations are 0.041 pg-TEQ/m^3 for ambient air, 0.21pg-TEQ/L for public water, 7.4 pg-TEQ/g for bottom sediment, 0.055 pg-TEQ/L for groundwater and 3.1 pg-TEQ/g for soil (See Table 3). Dioxin levels in the environment in FY 2007 almost achieve environmental quality standards. In FY 2007 100% of all monitoring points for ambient air and soil, 97.5% for public water, 99.5% for bottom sediment and 99.7% for groundwater achieved the standards.

Table 3 Dioxins Levels in the Environment

			FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007
Ambient air		Average	0.55	0.23	0.18	0.15	0.13	0.093	0.068	0.059	0.052	0.050	0.041
		Range	0.010 ~ 1.4	0.0 ~ 0.96	0.0065 ~ 1.1	0.0073 ~ 1.0	0.0090 ~ 1.7	0.0066 ~ 0.84	0.0066 ~ 0.72	0.0083 ~ 0.55	0.0039 ~ 0.61	0.0053 ~ 0.40	0.0042 ~ 0.58
		No. of sites	68	458	463	920	979	966	913	892	825	763	740
Public water bodies	Water	Average	–	0.50	0.24	0.31	0.25	0.24	0.24	0.22	0.21	0.21	0.21
		Range	–	0.065 ~ 13	0.054 ~ 14	0.012 ~ 48	0.0028 ~ 27	0.010 ~ 2.7	0.020 ~ 11	0.0069 ~ 4.6	0.0070 ~ 5.6	0.014 ~ 3.2	0.0097 ~ 3.0
		No. of sites	–	204	568	2,116	2,213	2,207	2,126	2,057	1,912	1,870	1,818
	Sedi-ment	Average	–	8.3	5.4	9.6	8.5	9.8	7.4	7.5	6.4	6.7	7.4
		Range	–	0.10 ~ 260	0.066 ~ 230	0.0011 ~ 1,400	0.012 ~ 540	0.0087 ~ 640	0.057 ~ 420	0.050 ~ 1,300	0.045 ~ 510	0.056 ~ 750	0.044 ~ 290
		No. of sites	–	205	542	1,836	1,813	1,784	1,825	1,740	1,623	1,548	1,505
Ground-water		Average	–	0.17	0.096	0.092	0.074	0.066	0.059	0.063	0.047	0.056	0.055
		Range	–	0.046 ~ 5.5	0.062 ~ 0.55	0.00081 ~ 0.89	0.00020 ~ 0.92	0.011 ~ 2.0	0.00032 ~ 0.67	0.0079 ~ 3.2	0.0088 ~ 0.72	0.013 ~ 2.2	0.0076 ~ 2.4
		No. of sites	–	188	296	1,479	1,473	1,310	1,200	1,101	922	878	759
Soil		Average	–	6.5	–	6.9	6.2	3.8	4.4	3.1	5.9	2.6	3.1
		Range	–	0.0015 ~ 61	–	0 ~ 1,200	0 ~ 4,600	0 ~ 250	0 ~ 1,400	0 ~ 250	0 ~ 2,800	0 ~ 330	0 ~ 170
		No. of sites	–	286	–	3,031	3,735	3,300	3,059	2,618	1,782	1,505	1,285

(Note) Unit of Average and Range: Air pg-TEQ/m^3, Water pg-TEQ/L,Bottom Sediment pg-TEQ/g, Soil pg-TEQ/g

(Air)
I-TEF(1988) had been used for the calculation of toxicity equivalent until FY 1998 and WHO-TEF(1998) has been used since FY 1999.
(Water quality of public waters, groundwater and Soil)
WHO-TEF (1998) is used for the calculation of toxicity equivalent.

2 Impact of dioxins on wildlife is not clear. Research and surveys on the status of dioxin contamination in wildlife are now underway.

It is difficult to clarify the cause and effect relationship between dioxin contamination and disease or population decreases in wildlife since wildlife is exposed to various chemicals besides dioxins, and is also affected by many different factors (such as habitat loss or impact of human activities).

Since there are studies that show impacts of organochlorine compounds such as dioxins, PCBs, and DDT on the hatching of reptiles and birds, as well as other effects, further studies are needed in Japan and overseas.

4 How much dioxin do we take in everyday life?

1 We take in about 1.06 pg-TEQ of dioxins a day on average, an amount that is below the safety index (TDI), through food and respiration, etc.

The average dietary intake of dioxins including co-planar PCBs in Japan amounts to 1.04 pg-TEQ for each kg of body weight based on an average body weight of 50 kg, according to a FY 2006 survey by the Ministry of Health, Labour and Welfare (Survey on Daily Intake).

In addition to the dietary intake, with an assumed intake of about 0.015 pg-TEQ from the ambient air, and about 0.0038 pg-TEQ from the soil via dirt on hands, etc., the total dioxin intake of a person in Japan amounts to 1.06 pg-TEQ/kg body weight/day on average (See Fig. 3). This level is below the Tolerable Daily Intake (TDI) and thereby regarded as being below the level that causes adverse effects on human health.

2 Since dioxins tend to accumulate in adipose tissue, dietary intake level is particularly large from seafood, meat, dairy products and eggs.

Because dioxins are lipid soluble and tend to accumulate in adipose tissue, seafood, meat, dairy products and eggs are most likely to contain them. In Japan the main source of dietary intake of dioxins is fish, while the main sources are meat and dairy products in Europe and the United States, reflecting differences in dietary habits. In any country, 70 to 90 % of the dietary intake of dioxins is likely to come from the intake of seafood, meat, dairy products and eggs.

The intake of dioxins from vegetables is considered to be significantly less than that from seafood or meat.

3 Dioxins accumulate to the adipose tissue in particular. The half-life for elimination from the body is about seven years.

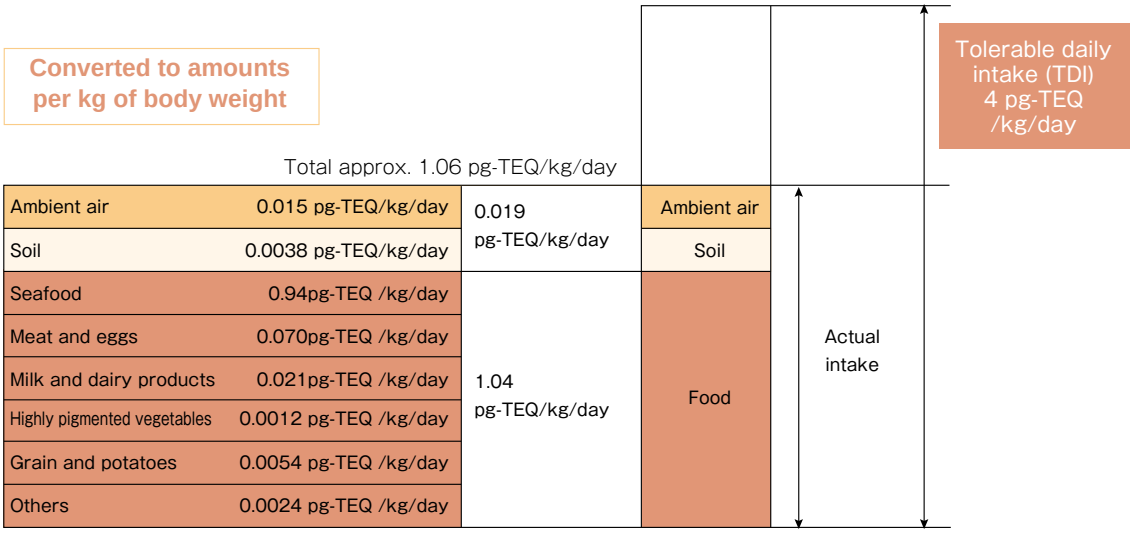
Once dioxins are absorbed into the body, these compounds remain mostly in the adipose tissue. The rate of excretion after decomposition etc. of dioxins is very slow. It is reported to take about seven years for dioxin concentrations to be reduced by one half in humans.

4 It is important to maintain a balanced diet not to exceed the TDI, the safety index.

Concentrations of dioxins vary with food items and with location and seasons of production even for the same type of food. For this reason, the intake through a regular diet is thought to be lower than the TDI when averaged over a long period of time and no problem is likely to emerge even if intake on a particular day exceeds the TDI of 4 pg- TEQ/kg body weight/ day.

According to the results of a Ministry of Health, Labour and Welfare survey on the daily intake of dioxins, the dioxin intake of a person eating the average diet (as defined in the National Nutrition Survey) is estimated to be below the TDI of 4 pg-TEQ/kg body weight/ day. Since nutrients from various foodstuffs are essential for health, it is important to follow a balanced diet with an abundant variety of food items.

Figure 3: Daily Intake of Dioxins in Japan (Fiscal Year 2006, TEF-WHO (1998))

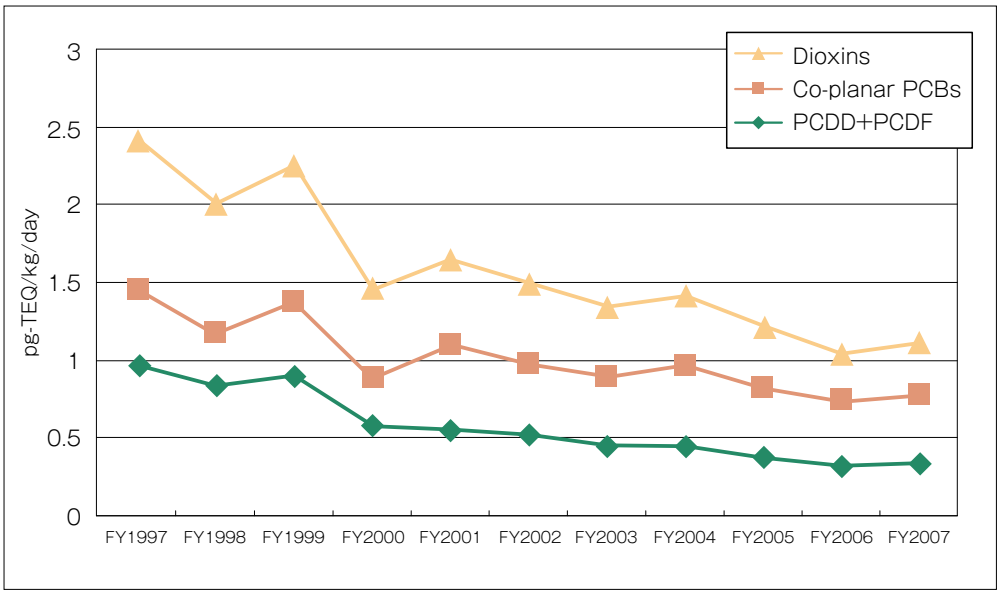


5 Intake of dioxins from food has decreased greatly since 20 years ago.

Specimens from past daily intake surveys in the Kansai region preserved by the Ministry of Health, Labour and Welfare, when analyzed for dioxins, indicated that daily intake of dioxins has dropped to almost one third during these 20 years (See Fig. 4).

Further decreases in intake are expected as a result of measures to reduce dioxins emissions.

Figure 4: Chronological Change in Daily Intake of Dioxins from Food



Source: Ministry of Health, Labour and Welfare: Total Diet Study for Dioxins

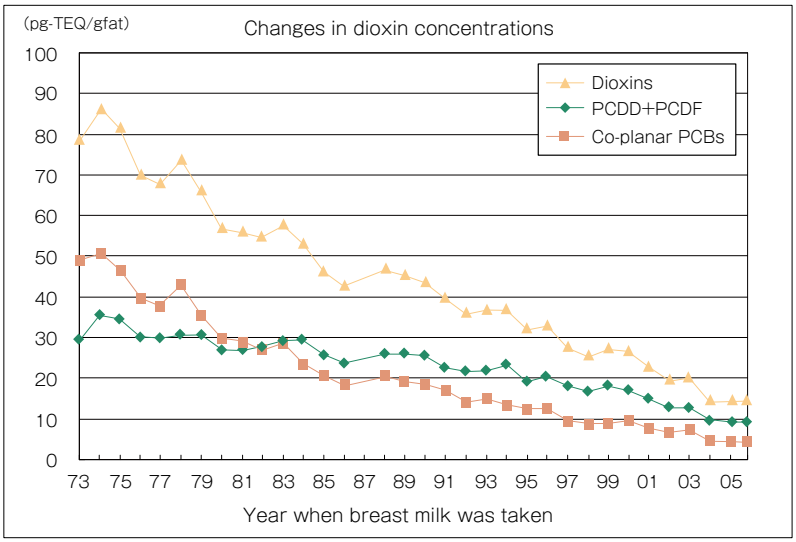
6 The concentration of dioxins in breast milk in Japan is almost the same as in other developed countries, and there are reports that describe the decline of dioxins concentrations to nearly one-fifth the level during the last 30 years. Breast-feeding should continue to be encouraged, considering the beneficial effects that it has on infants.

A concentration of 25.2 pg-TEQ/1 g of fat was found to be the average concentration of dioxins in mother's milk by a FY 1998 nationwide survey, which analyzed breast milk from 415 primipara mothers in 21 areas, 30 days after they gave birth. This concentration is considered similar to that of other countries. According to data taken continuously thereafter in selected areas, the levels of dioxins showed a declining trend. By FY 2006, the average concentration of dioxins in breast milk had decreased to 16.3 pg-TEQ/1 g of fat. No effects on resistance to infection, allergic reaction, thyroid functions or growth and development due to dioxins were observed in one-year old infants.

An ongoing study on dioxins in preserved breast milk shows that dioxin concentrations have declined since 1973 to approximately 1/3 to 1/10 today, depending on the dioxin compositions (See Fig. 5).

Further research is planned on the effects of dioxins ingested by infants via breast milk. Meanwhile, breastfeeding should continue to be encouraged, considering its beneficial effects on infant development. The WHO Consultation concluded similarly that there should be no change in the WHO policy of promoting breastfeeding.

Figure 5: Dioxin concentrations in breast milk



Source: FY 2007 Health and Labour Science Research Grants
"Studies on Dioxins in Breast Milk"

5 What measures are being taken against dioxins?

1 Government ministries and agencies are working together to tackle dioxin issues through emission controls and improvement of waste incinerators.

It is assumed that about 90% of the dioxin emissions, of PCDDs and PCDFs in particular, are emitted from the incineration of household or industrial waste in Japan. Accordingly, measures such as emission gas controls on waste incinerators and other sources, and improvements of incineration facilities, have been imposed since December 1997 based on the Air Pollution Control Law and Waste Management and Public Cleansing Law.

In the meeting of the Ministerial Council on Dioxin Policy held on March 30, 1999, the Basic Guidelines of Japan for the Promotion of Measures against Dioxins were established (revised on September 28) and the Ministries and Agencies concerned are now diligently promoting various unified measures aiming for a significant reduction in dioxin emissions.

The Law Concerning Special Measures against Dioxins (the Dioxins Law) was promulgated in July 1999 and enacted on January 15, 2000. This law provides basic standards for the measures concerning dioxins as well as necessary regulations or measures against polluted soil in order to prevent or remove environmental pollution caused by dioxins. Current measures against dioxins were implemented based on this law.

Enforcement of these laws has reduced pollution caused by dioxins, as shown above. Dioxin emissions have steadily decreased, dioxin concentrations in ambient air and public water now almost achieve environmental quality standards nationwide, and average concentration of dioxins in humans has decreased to below the standard level.

Outline of the Basic Guidelines of Japan for the Promotion of Measures against Dioxins

○ The total national emission of dioxins is to be reduced to approximately 90% below the 1997 level within four years.

○ Based on these Guidelines, in addition to smoothly executing the Law Concerning Special Measures against Dioxins which was enacted in July 1999, the Government will strongly promote the following measures in collaboration with local governments, business and citizens.

1. Reevaluating the Tolerable Daily Intake (TDI) and establishing standards
2. Promoting measures to reduce the emission of dioxins
3. Improving inspection systems relating to dioxins
4. Executing fact-finding studies into the impacts of dioxins on human health and environment
5. Promoting research and development
6. Promoting waste management and recycling
7. Providing the public with accurate information and promoting information disclosure
8. Contributing to the international community

Law Concerning Special Measures against Dioxins (The Dioxins Law)

[Approved on July 12, 1999, promulgated on July 16, 1999 and entered into force on January 15, 2000.]

Outline of the Law

1. Basic standards for formulating policies on dioxins
   1) Tolerable daily intake (TDI) (Article 6)
   2) Environmental standards for ambient air, water quality (including sediment) and soil (Article 7)
2. Regulations for emission gas and effluent relating to dioxins
   1) Specified facility
   2) Emission standards (Article 8)
   3) Total mass emission standards (Article 10)
   4) Notification of the establishment of specified facilities/Order for modification of plans (Articles 12-16)
   5) Restriction on emissions/Order for improvement (Articles 20-22)
3. Disposal of ash and dust relating to waste incinerators, etc.
   1) Standards for ash and dust (Article 24)
   2) Standards for maintenance and management of final landfill site (Article 25)
4. Measures against soil contamination by dioxins (Articles 29-32)
   1) Designation of the areas for the measures against soil pollution by dioxins (Article 29)
   2) Plan formulation for the measures against soil pollution by dioxins (Article 31)
5. Government plan for the reduction of dioxin emissions (Article 33)
6. Obligations for monitoring and surveillance of the level of pollution caused by dioxins (Articles 26-28)
   1) Regular monitoring by the local governments (Article 26)
   2) Measuring the specified facilities by the people who established them. (Article 28)
7. Date of enforcement (Supplementary provisions Article 1)
8. Review (Supplementary provisions Articles 2-3)

・Promotion of research and study of bromine-based dioxins
・Reviews based on scientific knowledge by taking into consideration the health risk and accumulation of dioxins in food
・Reviews on the status of regulations for small-scale waste incinerators

Basic Standards for the Measures Concerning Dioxins

The Dioxins Law prescribes the tolerable daily intake (TDI) and environmental quality standards as basic standards for the measures.

Tolerable daily intake (TDI) 4 pg-TEQ/kg/day (4 pg per day for each kg of body weight)
Environmental quality standards for:

ambient air annual average: not more than 0.6 pg-TEQ/m^3
water annual average: not more than 1 pg-TEQ/L
bottom sediment not more than 150 pg-TEQ/g
soil not more than 1,000 pg-TEQ/g (survey level: 250 pg-TEQ/g)*.

*If the soil monitored exceeds the survey level, an additional survey will be conducted.

Regulations for Emission Gas and Effluent Water Relating to Dioxins

The control standards for dioxins for emission gas and effluent have been prescribed in the Dioxins Law at the strictest values achievable at present.

1 Emission standards

(Unit: ng-TEQ/m^3 N)

Type of Specified Facilities	Scale of facilities (Capacity of incineration)	Standards for new facility	Standards for existing facility
Waste incinerators (hearth area is more than 0.5 m^2 or capacity of incineration is more than 50 kg/h)	More than 4t/h	0.1	1
	2t/h - 4t/h	1	5
	Below 2t/h	5	10
Electric steel-making furnaces		0.5	5
Sintering facilities for steel industry		0.1	1
Facilities for recovering zinc		1	10
Facilities for manufacturing aluminum base alloy		1	5

Note: Regarding newly constructed waste incinerators (capacity is more than 200 kg/h) and electric steel-making furnaces to which the standards for controlling prescribed materials in the Air Pollutions Control Law have already been applied, emission standards in the above chart for a new facility are applied.

2 Effluent standards

(Unit: pg-TEQ/L)

Type of Specified Facilities	Standard
・Bleaching facilities using chlorine or chlorine compounds used for manufacturing sulfate pulps(kraft pulps) or sulfite pulps. ・Cleansing facilities for acetylene used for manufacturing acetylene by carbide method ・Cleansing facilities for waste gas used for manufacturing potassium sulfate ・Cleansing facilities for waste gas used for manufacturing alumina fiber ・Cleansing facilities for waste gas which is released from firing furnaces used for manufacturing supported catalysts (limited to those that use chlorine or chlorine compounds) ・Cleansing facilities for dichloroethane used for manufacturing vinyl chloride monomer* ・Sulfuric acid concentration facilities, cyclohexane separation facilities, and waste gas cleansing facilities used for manufacturing caprolactam (limited to using nitrosyl chloride) ・Water washing facilities and waste gas cleansing facilities used for manufacturing chlorobenzene or dichlorobenzene ・Filtration facilities, drying facilities and waste gas cleansing facilities used for manufacturing sodium hydrogen 4-chlorophthalate ・Filtration facilities and waste gas cleansing facilities used for manufacturing 2,3-dichloro-1,4-naphthoquinone ・Nitro-derivative and its reductant separation facilities, nitro-derivative and its reductant cleansing facilities, dioxazineviolet cleansing facilities, and hot-air drying facilities used for manufacturing dioxazineviolet ・Cleansing facilities for waste gas and wet dust collecting facilities relating to roasting furnaces, melting furnaces or dry kilns used for manufacturing aluminum or aluminum-base alloy ・Refining facilities, waste gas cleansing facilities, and wet dust collecting facilities used for recovering of zinc (limited to zinc recovery from dust that is generated from electric steel-making furnaces and collected by dust-collector) ・Filtration facilities, refining facilities and waste gas cleansing facilities used for collecting metals from spent supported catalysts (excluding collection methods that treat catalysts with sodium carbonate in a roasting furnace or extract metals with alkalis (limited to those that do not treat in a roasting furnace)) ・Cleansing facilities, wet dust collecting facilities, and ash storing facilities which are related to waste incinerators (hearth area is more than 0.5m^2 or capacity of incineration is more than 50 kg/h) and discharge sewage or waste solution* ・Resolving facilities for waste PCB or PCB-processed products ・Cleansing facilities for PCB contaminated matter or PCB-processed products ・Plasma reactors, waste gas cleansing facilities, and wet dust collecting facilities used for breaking down chlorofluorocarbons or hydrochlorofluorocarbons (limited to those employing the plasma reaction, waste mixed combustion, submerged combustion, or superheated steam reaction method) ・Facilities for disposing water discharged from plants or business places with facilities mentioned above ・Terminal treatment facilities for sewerage relating to facilities mentioned above	10

Note: The standard relating to water emitted from terminal waste disposal facilities is 10 pg-TEQ/L based on instructions stipulating standards for maintenance and management based on the Waste Disposal and Public Cleaning Law.

The Government's Dioxins Reduction Plan

The Government formulated the "Government Plan to Reduce Dioxin Levels Resulting from Business Activities in Japan" based on the Dioxins Law in September 2000. This plan established the target for the amount of reduction in dioxin emissions at the end of FY 2002 (843~891g-TEQ/year) and the target for the amount of reduction in dioxin emissions of each business sector, and also prescribes measures to achieve those targets. In 2003, the estimated amount of dioxin emissions was reduced by approximately 95% from that of 1997, and the policy objective was achieved.

However, the Central Environmental Council (Nov. 12, 2004) called the need to monitor the risk of dioxin pollution over the long term, given the facts that dioxins are not easily decomposed in the environment, and dioxins once emitted into the environment continue to accumulate.

Based on this proposal, the government modified the national plan in June 2005. The revised plan targets 315-343 g-TEQ/year as the total amount of dioxin emissions by 2010. It also called for an approximately 25% reduction in dioxins emission from waste incinerators by reducing waste through various policies designed to help establish a recycling-oriented society (policies based on the basic plan to promote the creation of a recycling-oriented society, measures prescribed by various recycling laws, promotion of the 3Rs—reduce, recycle, reuse—, etc.), as well as a reduction of approximately 15% from 2003 of the amount of dioxin emissions from industrial facilities by keeping dioxin levels below present levels.

1. Reduction targets relating to the estimated amount of dioxin emissions categorized by the field of business activities in Japan
2. Measures for businesses in order to achieve reduction targets
3. Measures to be taken by the national government and local public authorities to promote the recycling and reuse of resources, and to reduce waste which could emit dioxins
4. Other matters necessary to reduce dioxins resulting from business activities in Japan

2 Ministries and Agencies concerned are cooperating to promote studies for further elucidation of human exposure levels, research on assessment of health effects, technological developments for proper waste management, cleaning of contaminated soil, detoxification and decomposition of contaminants and improvement of the inspection system.

The Government is conducting research and surveys on the environmental fate of dioxins (behavior of dioxins from environmental emissions to human intake), human exposure assessment (grasping the amount of dioxins taken in by humans via various routes), and assessment of health effects and impacts on living organisms. At the same time, it is working on technological developments relating to proper waste incineration, cleaning of contaminated soil, detoxification and decomposition of dioxins, and simplified analytical methods.

In addition, guidelines for which analysis authorities themselves will follow have been arranged in order to actualize eligible precision management and promote improvement of the inspection system. Guidelines which commissioned institutions and facilities will follow have been arranged so as to ensure reliability when analysis authorities commission external institutions and overseas facilities.

These research and development activities are promoted by the ministries and agencies concerned in a coordinated manner and their results will be fully utilized in measures for the reduction of dioxin emissions.

Measures for Workers Relating to Waste Incinerators

So as to prevent negative health effects imposed upon the workers at waste incineration sites and the workers who demolish waste incineration facilities, various measures, such as workers' education on safety and hygiene, selection of supervisors, creation of a wet environment, use of proper protective equipment and measurement of dioxins concentration, have been taken. Efforts to familiarize and enforce those measures have been made.

Simplified Analytical Methods for Dioxins

Trace amounts of dioxins are measured using a high-resolution gas chromatograph mass spectrometer. However, since this method requires time and money, the development and application of an inexpensive, speedy and simplified Analytical method was being sought. From September 2005, four types of simplified Analytical methods became available for the measurement of gas emissions from waste incinerators (limited to those with a burning capacity of less than 2,000 kg/h), ash and certain cinders.

Yusho and PCBs/Dioxins

Yusho occurred in 1968 mostly in Kyushu. At that time, PCBs were considered to have caused Yusho. However, following research revealed that contaminated rice oil contained not only PCBs but also several chemicals including PCDFs and PCDDs.

Present scientific knowledge shows that PCBs have 209 congeners, PCDFs 135, and PCDDs 75. But there was no clear understanding of dioxins around 1975 even though TCDD was researched as a dioxin. Thus, almost nothing was found out about toxicity and nature of PCDFs and other compounds.

NATO and WHO, in 1988 and 1990, respectively, set TEFs for some PCDD and PCDF compounds, and then the total toxic amount calculated by TEFs was called TEQ. This means that some kinds of PCDD and PCDF compounds were officially understood as dioxins.

The group of PCBs called co-planar PCBs was also recognized as having the same toxicity as dioxins, and WHO set TEFs for 13 PCB compounds in 1994. Certain PCB compounds were thus internationally recognized as dioxins.

In Japan, some kinds of PCDD and PCDF compounds were officially recognized as dioxins in 1996. In 1999, some PCB compounds were also officially recognised.

Once PCB and dioxins are ingested by a Yusho patient, they are gradually discharged from the body through bowel, skin, breast milk and sputum, and their concentration in the body decreases. As dioxins in the body were trace, it has been difficult to measure them accurately. However, efforts of the research group have recently made it possible to analyze dioxins in a small sample of blood. Therefore, the levels of 2,3,4,7,8-PeCDF in the blood were added to the diagnostic criteria in 2004.

Japan will continue to promote the development of medical treatments and so on more actively.

Stockholm Convention on Persistent Organic Pollutants

Among chemicals toxic to humans, some remain intact in the environment for long periods, and accumulate in the fatty tissue of living organisms. They are called Persistent Organic Pollutants (POPs). POPs circulate globally and can cause damage to the environment in many countries. Therefore, every government in the world needs to cooperate in tackling the POPs issue.

The Stockholm Convention on Persistent Organic Pollutants was adopted in May 2001. Japan acceded to this Convention in August 2002, and the Convention came into force in May 2004. The Convention requires each Party to reduce unintentionally produced polychlorinated dibenzo-p-dioxins and dibenzofurans, hexachlorobenzenes, and PCBs with the goal of eliminating them to the greatest extent possible.

In June 2005, Japan's National Implementation Plan for implementing the obligations under the Convention was endorsed by the "Council of Ministers for Global Environmental Conservation." The plan contains an action plan for reducing unintentionally produced POPs, which corresponds to the "Government Plan to Reduce Dioxins Levels Resulting from Business Activities in Japan."

6 What can we do to limit dioxin emissions in everyday life?

1 The most important matter is that each of us becomes concerned with dioxins issues, tries to reduce waste by using products as long as possible and by avoiding the use of disposable goods, and takes part in reuse, segregated disposal and recycling.

Since dioxins are formed in combustion processes, reducing the amount of waste is an effective way to lessen dioxin emissions.

Accordingly, Containers and Packaging Recycling Laws such as the Fundamental Law for Establishing the Recycling-based Society were put into effect. These laws were promulgated to avoid generating waste, to reuse waste as resources, and to dispose of waste that is impossible to reuse as resources in proper ways without causing dioxin emissions. From now on, it is most important for each of us to become concerned with dioxin issues, try to reduce waste by using products as long as possible and by avoiding disposable goods, and taking part in reuse, segregated disposal and recycling.

It has been reported that the incineration of waste containing chlorine, such as polyvinyl chloride, may result in higher concentrations of dioxins in some cases if the incineration is not properly controlled. However, if appropriate measures and controls are taken, the influence of polyvinyl chloride and other chlorine compounds in waste becomes a relatively smaller factor, and on the other hand, the combustion and waste-gas treatment conditions become more important factors affecting the concentrations of dioxins. Accordingly, dioxin concentrations in emissions can be limited by adopting the proper measures and controls.

2 Open burning of waste is prohibited in principle. Small-scale incinerators, to which dioxin emission controls do not apply, also have structural standards. Your further cooperation is strongly requested, such as sorting waste and controlling emissions correctly, which is indicated by the municipal waste disposal plan.

Since April 2001, by revision of the Waste Management and Public Cleansing Law, there is a prohibition of and penalty for burning waste outside with some inevitable exceptions such as traditional events and customs and burning for agricultural purposes.

Small-scale incinerators, to which dioxin emission standards are not applied, need to be able to burn at 800 degrees and higher and the structure must include a thermometer and devices for supporting combustion.

In view of reducing the total amounts of dioxins, the incineration of household waste using small-scale incinerators, which is comply with structural standards for home use, is not appropriate. It is desirable that the waste be treated at municipal incineration facilities that meet legal standards. For the disposal of household waste, your cooperation is highly requested in efforts to dispose of waste according to the rules of the municipality such as segregated disposal.

Structural Standards for Waste Incinerators (Article 1-7, Order of the Ministry of the Environment under the Waste Management and Public Cleansing Law (Outline))

1. Municipal solid waste shall be incinerated inside equipment from which the outer air shall be shut out except the air intake and the tip of the chimney and by maintaining the surface temperature of combustion gas generated in the combustion chamber at 800 degrees centigrade or more.
2. The amount of air shall be taken for incineration.
3. Waste shall be put into the combustion chamber by a set amount with maintaining the outer air of being shut out from there (except those taking gasified incineration method or others which are recognized that there is no other way due to its structure).
4. A facility shall be equipped with a device to measure the temperature of the combustion gas in the combustion chamber.
5. A facility shall be equipped with an auxiliary combustion device necessary to maintain the temperature of the combustion gas.

Please address your opinions and inquiries to:

Office of Dioxins Control,
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