

## Detailed Study of Dioxin Exposure: Findings of the Fiscal 1999 Survey

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### Summary of Research

#### (1) Objectives and Content of Study

The objective of this Detailed Survey of Dioxin Exposure conducted in fiscal 1999 was to determine and accurately measure the levels of human and ecosystem exposure to dioxins (PCDDs, PCDFs, and co-planar PCBs are referred to as "dioxins") in order to evaluate its effects on human health and the environment. Areas in the vicinity of waste incineration facilities (A regions) and control areas (B regions) were identified in the Nose Town area of Osaka Prefecture, the Saitama Prefecture areas (including Tokorozawa City, Sayama City, Kawagoe City.), and the Fuchu City area in Hiroshima Prefecture. After we selected the survey sites, we sampled residents of the sites. Measurements were made of concentrations of dioxins in blood. These concentrations are considered to be indicators of long-term exposure to dioxins. In addition, environmental studies (ambient air, indoor air, soil, ground surface sampling and so forth.) were conducted, as well as food surveys and questionnaire surveys about dietary habits and smoking history of the subjects.

In addition, tests were carried out to determine whether or not activation of drug-induced enzymes, and effects on immune functions, which are known to result from minute amounts of dioxins in animal experiments, could be discerned in the subjects of the study in each region.

The findings of the Fiscal 1999 Detailed Study of Dioxin Exposure have been organized under the following five headings according to the analysis results:

- (a) Blood survey
- (b) Environmental survey
- (c) Food survey
- (d) Evaluation of exposure to dioxins
- (e) Comparison of fiscal 1998 and 1999

#### (2) Findings

##### (a) Blood survey

Adjusted for age, the mean and median dioxin concentrations in the blood were similar in A and B regions in the Nose Town area of Osaka Prefecture, the Saitama Prefecture areas, and the Fuchu City area in Hiroshima Prefecture. (The mean concentrations were 26 to 29 pg-TEQ/g-fat in the A regions, and 24 to 30 pg-TEQ/g-fat in the B regions.) The range of dioxin concentrations in the blood for survey subjects in all areas was 5.3 to 70 pg-TEQ/g-fat, which falls within the ranges observed in preceding surveys conducted in Japan.

##### (b) Environmental survey

The concentrations of dioxins in the air during the period of the survey were approximately equal for A and B regions in the Nose Town area of Osaka Prefecture. In the Saitama Prefecture areas, the measurement tended to be higher in B regions than in A regions. In the Fuchu City area of Hiroshima Prefecture, the levels in the A regions showed a tendency to be higher than in the B regions. However, the difference between the A and B regions was not statistically significant. The concentrations of dioxins in indoor air generally correlated to ambient air concentrations. The results from measurement of dioxins in the soil in the Nose Town area of Osaka Prefecture showed lower levels in the A regions than in the B regions. In the areas of Saitama Prefecture and Fuchu City in Hiroshima Prefecture, the A regions tended to show higher levels than the B

regions, but the differences were not statistically significant.

(c) Food survey

Both mean and median levels of estimated exposure to dioxins through foods were lower in the A regions than in the B regions in the Nose Town area of Osaka Prefecture, whereas they were higher in the A regions than in the B regions in the Saitama Prefecture areas. In the Fuchu City area of Hiroshima Prefecture, these levels were lower in the A regions than in the B regions. Comparison of corresponding regions did not show distinct differences in any of the three areas. In fiscal 1998, the food survey was conducted once for a three-day period for each household (a total of three times), whereas in fiscal 1999, the food survey was conducted three times each day for the three-day period (a total of nine days). This change is thought to have resulted in a smoothing of measurements of the amount of dioxin intake from the food.

(d) Evaluation of Exposure to Dioxins

The estimated levels of exposure to dioxins were compared between regions. The results show that in the Nose Town area of Osaka Prefecture, both mean and median values were lower in A regions than in B regions. In the Saitama Prefecture areas, both mean and median values were higher in A regions than in B regions. In the Fuchu City area of Hiroshima Prefecture, both mean and median values were lower in A regions than in B regions.

In every region, food accounted for more than 90% of the total dioxin exposure, and the air and soil accounted for relatively little.

In every region, the mean and median values for estimated total exposure to dioxins were below the tolerable daily intake (TDI) of 4 pg-TEQ/kg/day. Because the values for estimated total exposure to dioxins obtained in this survey are from cross-sectional study during the period of the study, they cannot simply be compared directly with the daily value of 4 pg-TEQ/kg. Nevertheless, two survey subjects out of 120 exceeded that value. In fiscal 1999, the food survey was conducted over a total of nine days, with daily samples taken over three-day periods three different times. Therefore, the measurements of dioxin intake from the food was smoothed out, and similar tendencies were observed with respect to total exposure levels.

No clear link was observed between the estimated total exposure to dioxins and the concentration of dioxins in the blood during the survey period.

(e) Comparison of fiscal 1998 and fiscal 1999

Some of the subjects in some sites who participated in 1998 survey also participated in 1999 survey in the Nose Town area of Osaka Prefecture and the Saitama Prefecture areas. No difference in blood and air measurements were observed between the two years.

(3) Summary

This survey included blood surveys to determine dioxin accumulation in human subjects. In addition, environmental and food surveys were conducted, in order to estimate total dioxin exposure levels through different exposure routes. The results did not show any clear difference between test and control regions in the dioxin accumulation in human subjects. In addition, no clear difference was detected between these areas when comparing estimated total exposure through the exposure routes studied.

For reference: No clear differences were observed in residential areas with regard to the relationship between dioxin exposure and immune functions or inducible enzymes. No correlation was observed between concentration of dioxins in the blood and immune functions or inducible enzymes.

Notes:

1 Concerning dioxins and immune system functions:

It is known from animal experiments that exposure to minute quantities of dioxins result in alterations in lymphocyte composition and other changes (reduced CD4 counts, depressed NK cell activity) as well as inhibition of T-lymphocyte proliferation (tested by addition of PHA, Con-A).

2 Concerning dioxins and drug-induced enzymes:

It is known that cytochrome P450 drug-metabolizing enzymes are induced by a variety of polycyclic aromatic hydrocarbons. Cytochrome P450 1A1 (CYP1A1), cytochrome P450 1A2 (CYP1A2), and cytochrome P450 1B1 (CYP1B1), in particular, are highly inducible in response to TCDD. This suggests, therefore, that these have good potential to serve as molecular indicators of the effects of dioxin exposure in human beings.

## I. Survey Objectives

In order to conduct evaluations of the effects of environmental factors on human health, detailed estimates of exposure levels were made for each exposure route in conjunction with surveys of accumulations in human subjects aiming at more precise evaluations and determinations of exposure.

## II. Survey Outline

### 1. Geographical Areas of Survey

·Nose Town area of Osaka Prefecture

Regions in vicinity of waste incineration facilities (A regions) and control areas (B regions)

·Saitama Prefecture areas

Regions in vicinity of waste incineration facilities in three cities and two towns (Tokorozawa City, Sayama City, Kawagoe City, Miyoshi Town, Oi Town) in Saitama Prefecture (A1 regions)

Regions in vicinity of Tokorozawa Interchange and National Highway 463 (Tokorozawa City, Miyoshi Town) (A2 regions)

Corresponding control regions (B regions)

·Fuchu City area of Hiroshima Prefecture

Regions in vicinity of waste incineration facilities (A regions) and control areas (B regions)

Note: Control regions were selected for their distant location from waste incineration facilities.

### 2. Survey Subjects

As a rule, survey subjects were persons who met the following conditions:

- Those who have lived in the region for at least ten years, and have no plan to change their place of residence within one year
- Those who do not have to leave the survey region frequently for commuting to work, etc.
- Those who are 40 years or over and under 69
- Those who do not have any hindrance to the collection of blood samples, etc.

(The surveys in Nose A and B regions and Saitama A1 and B regions were continuations of the Fiscal 1998 Survey on Long-Term Impact of Exposure to Dioxins in the Air, therefore, the same survey subjects participated wherever possible for the current survey.)

### 3. Survey Method

- Local governments canvassed publicly for survey subjects. Explanatory meetings were then held and the purpose of the survey was set forth.
- Test samples of blood, air, soil, food, and so on, were collected and the concentrations of PCDDs, PCDFs, and co-planar PCBs were measured.
- Questionnaire surveys were carried out to get information about dietary habits and smoking history of subjects.
- Survey results were analyzed and summarized.

### 4. Survey System

The Study Group for the Detailed Study of Dioxin Exposure (the group chair was Tsuguyoshi Suzuki, Professor Emeritus, University of Tokyo, and the group included eighteen members) designed the survey and analyzed and evaluated the results. Working groups were also established in each area of the study, and they deliberated on the formulation of survey plans, the questionnaire for the surveys, and so on. The measurements of PCDDs, PCDFs, co-planar PCBs and so on were carried out by Shin-Nippon Meteorological & Oceanographical Consultant Co., Ltd.

## 5. Survey Time Period

	Osaka Prefecture Nose Town Regions	Saitama Prefecture Regions	Hiroshima Prefecture Fuchu City Regions
Canvass for subjects			
Hold explanatory meetings	12/2 12/8	11/25 (A1 region) 11/29 (B region) 12/14 (A2 region)	12/1
Collection of test samples			
Blood	2/15、 2/17、 3/23	12/6 (A1 region) 12/14 (B region) 12/20 (A2 region)	12/14、 12/15
Air	12/6 – 12/13 12/15 – 12/22	1/12 – 1/19 (A1 region) 1/25 – 2/1 (A1 region) 1/26 – 2/1 (A2 region)	2/24 – 3/2
Indoor air	12/6 – 12/13 12/15 – 12/22	1/12 – 1/19 (B region) 1/25 – 2/1 (A1 region) 1/26 – 2/1 (A2 region)	2/24 – 3/2
House dust	12/6 – 12/13 12/15 – 12/22	1/12 – 1/19 (B region) 1/25 – 2/1 (A1 region) 1/26 – 2/1 (A2 region)	2/24 – 3/2
Soil	12/11、 12/17	1/13 (B region) 1/27 (A1,A2 region)	2/26
Surface sampling	12/11、 12/17	1/13 (B region) 1/27 (A1 region)	2/26
Settled dust and soot	12/15 – 12/26	1/12 – 2/16	2/24 – 3/24
Food	December (early, mid-December) January (mid-, late January) March (early, mid-December)	December (early, mid-December) January (mid-, late January) March (early, mid-December)	December (early, mid-December) January (mid-, late January) March (early, mid-December)
Groundwater	2/13	-	3/1
River water	3/30	-	-
Long-term air	12/6 – 3/31	1/12 – 3/31	1/13 – 3/31

## 6. Number of Test Samples Collected

	Osaka Prefecture Nose Town Regions		Saitama Prefecture Regions			Hiroshima Prefecture Fuchu City Regions	
	A region	B region	A1 region	A2 region	B region	A region	B region
Blood	22	22	14	22	13	16	19
Air	6	7	8	5	6	5	5
Soil	8	8	8	5	6	5	5
Surface sampling	6	8	8	5	6	5	5
Settled dust and soot	6	7	8	5	6	5	5
Indoor air	7	7	8	5	6	5	5
House dust	7	7	8	5	6	5	5
Food	22	15	14	21	13	16	19
Groundwater	6	1	0	0	0	6	0
River water	2		0	0	0	0	0

## 7. Collection and Analysis of Test Samples

- Blood: Refer to Figures 1-1 and 1-2 for the flow of analysis.
- Air: Refer to Figure 1-3 for the flow of analysis.

In order to measure concentrations in air very close to residential areas, air samples were obtained as a rule by methods different from those used for general air monitoring surveys. The differences between the methods for this survey and the methods for general air monitoring surveys are as follows:

	Methods for this study	General monitoring methods
Type of collection device	Low-volume air sampler	High-volume air sampler
Placement of collection device	Height of 1.5 m	Height of 3 m or more
Period of collection	7 days	24 hours

- Indoor air: Refer to Figure 1-3 for the flow of analysis.
- Soil: Based on Provisional Manual for Soil Surveys Relating to Dioxins.
- Ground Surface sampling: Refer to Figure 1-4 for the flow of analysis.
- Food: Refer to Figure 1-5 for the flow of analysis.
- Groundwater, river water: Based on Manual for Water Surveys Relating to Dioxins.
- Settled dust and soot: Based on methods of fiscal 1998 Emergency National Survey on Dioxins.

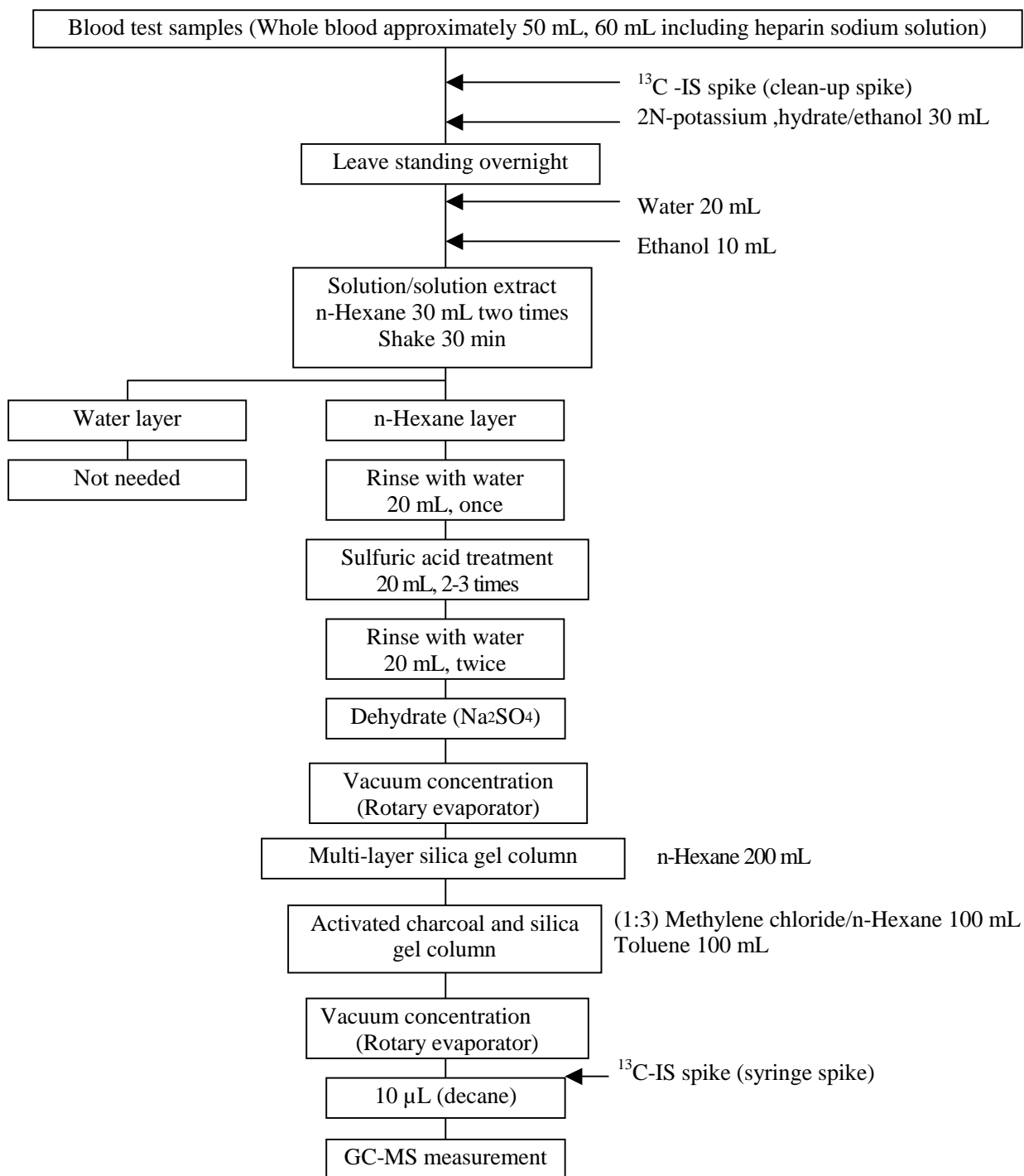


Figure 1-1. Flow of Analysis of Dioxins and Co-Planar PCBs in Blood

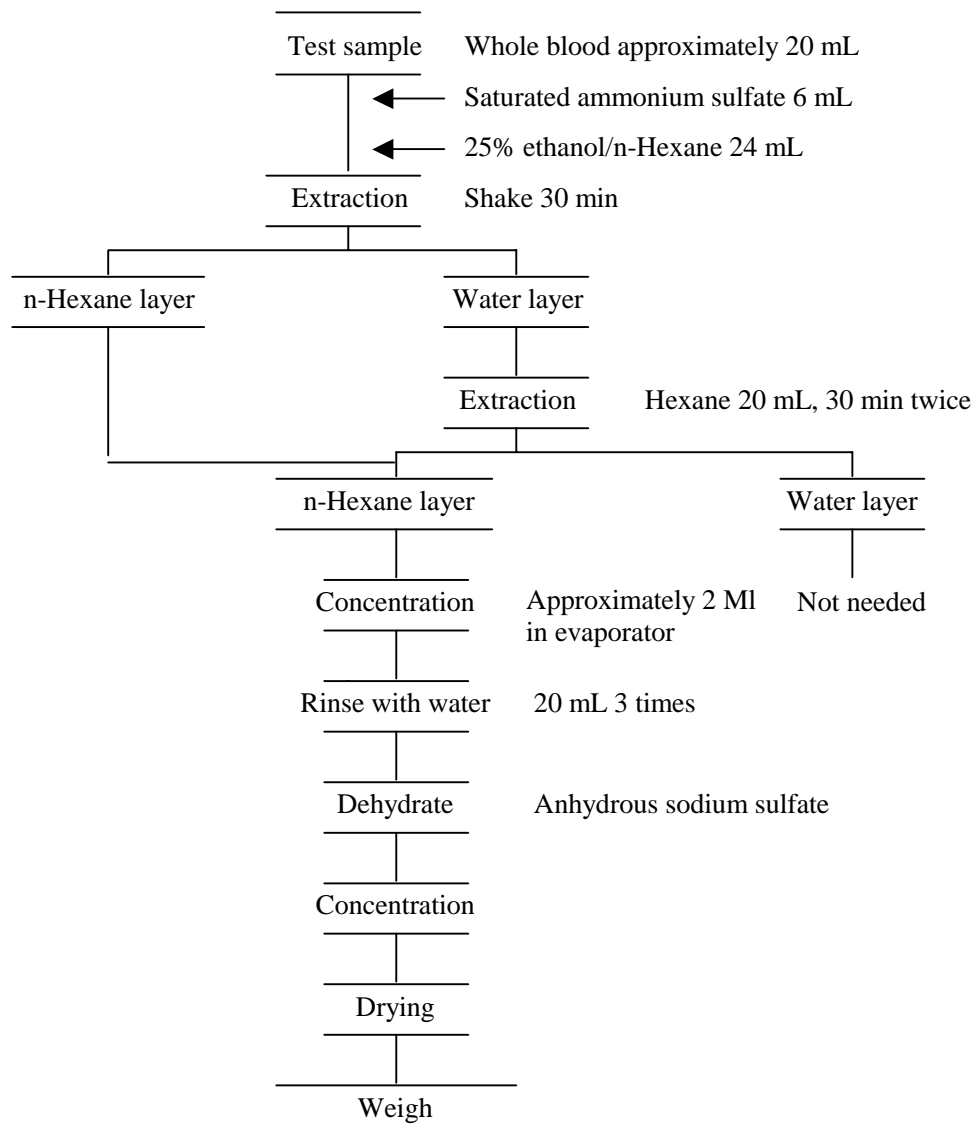


Figure 1-2. Flow of Analysis of Fat Content of Blood

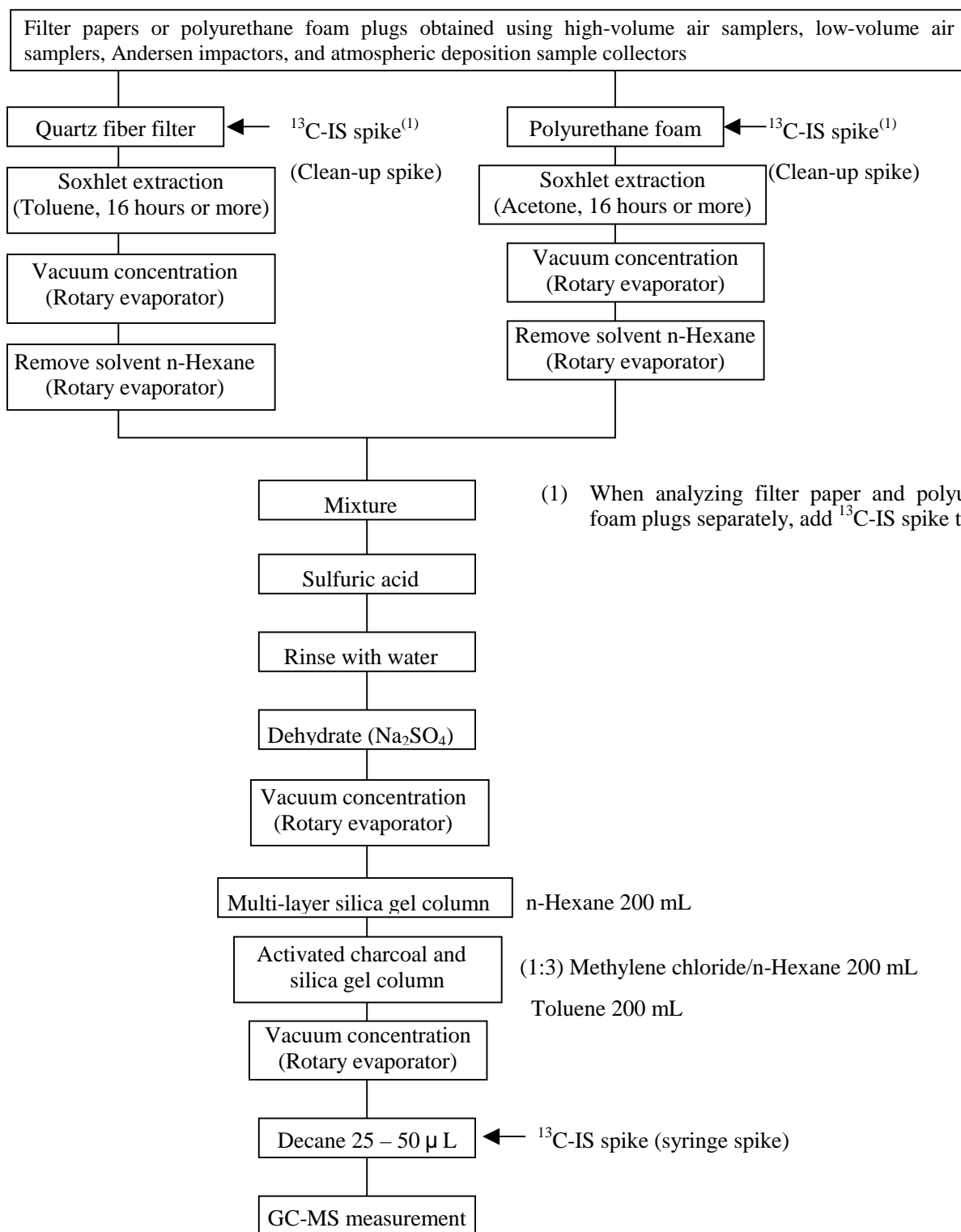


Figure 1-3. Flow of Analysis of Dioxins and Co-Planar PCBs in Test Samples from Air (Indoor, Outdoor) and Settled Dust and Soot



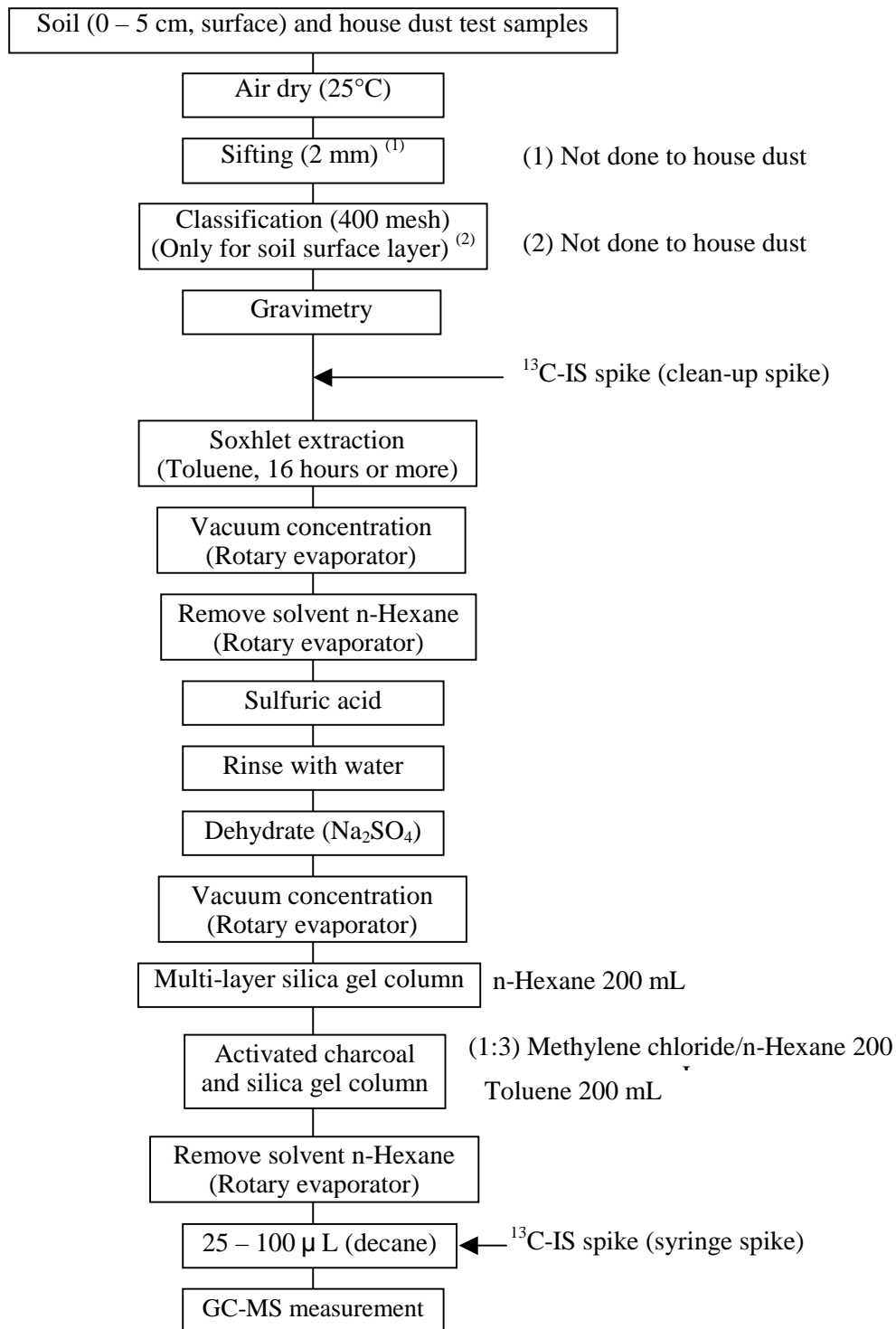


Figure 1-4. Flow of Analysis of Dioxins and Co-Planar PCBs in Soil and House Dust Test Samples

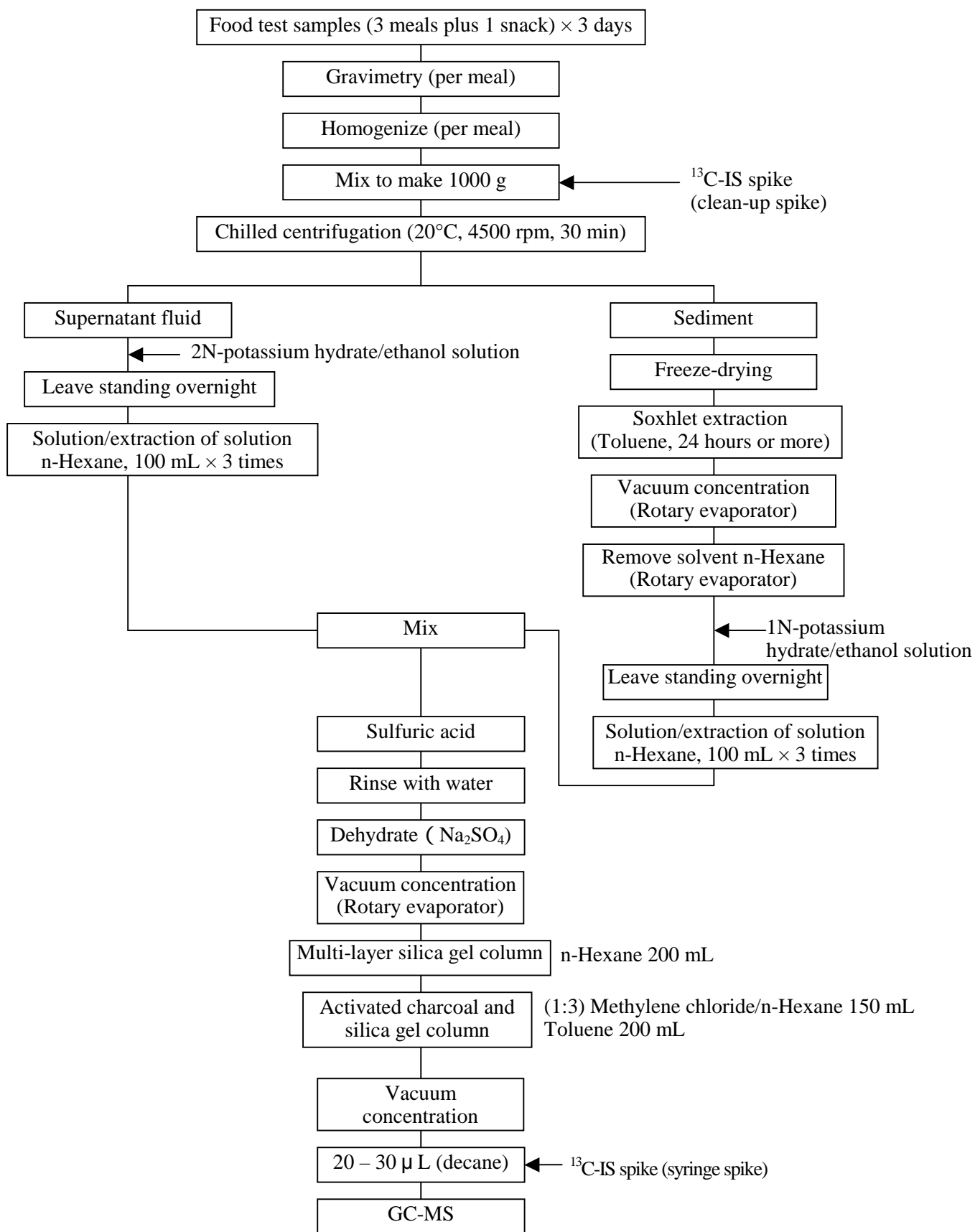


Figure 1-5. Flow of Analysis of Dioxins and Co-Planar PCBs in Food Test

### III. Findings and Evaluation

This survey involved studies of blood, air, soil, food, and so on. The findings are reported here.

The terminology, the toxicity equivalency factors used for conversion, and the handling of values below the detection limit in these findings are as follows:

- Terminology

As a rule, this report refers to polychlorinated dibenzo-p-dioxins as PCDDs, to polychlorinated dibenzofurans as PCDFs, and to co-planar polychlorinated biphenyls as co-planar PCBs (abbreviated Co-PCBs). Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans together are referred to as PCDD+PCDF, while polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and co-planar polychlorinated biphenyls together are referred to as PCDD+PCDF+Co-PCB.

- Toxic equivalency factors

The toxic equivalency factors (TEFs) used are WHO TEF, 1998.

- Handling of values below the detection limit, etc.

Measurement results were aggregated by area and region for each medium of exposure. Figures below the lower limit of determination (not detected: ND) were handled as follows: When the actual measurement of an isomer was below the lower limit of determination (ND), its actual concentration was assigned zero value in the calculations. For reference purposes, the results are also shown for those isomers that were measured as ND by applying 1/2 value of the detection limit as the actual concentration. However, the measurement values in this survey were more or less the same regardless of the method used for handling levels below the lower limit of determination (ND). Moreover, results of past surveys often assigned a zero value to levels below the lower limit of determination (ND). The analysis and evaluation of the data, therefore, treated ND results as zero values.

1. Test Subjects

The number, median ages, and so on of test subjects who participated with this survey are shown by region in Table 1-1.

Table 1-1. Number and Median Age, etc. of Test Subjects

	Osaka Prefecture Nose Town Regions		Saitama Prefecture Regions			Hiroshima Prefecture Fuchu City Regions	
	A regions	B regions	A1 regions	A2 regions	B regions	A regions	B regions
Number of subjects	22	15	14	22	13	16	19
Male	11	7	4	4	5	8	10
Female	11	8	10	18	8	8	9
Median age	50	53	54	53	51	55	62
Median years in residence	17	40	27	19	24	33	49

The regions were also compared (Table 1-2) in terms of dietary habits, smoking history, pregnancy and birth history, and so on based on the survey questionnaire results.

With respect to dietary habits, the three areas showed no clear difference in the frequency of ingestion of shore fish, beef, pork, and chicken eggs. In the Fuchu City area of Hiroshima Prefecture, the frequency of ingestion of other fish was higher in the A regions than in the B regions, while the frequency of ingestion of beef was higher in the B regions than in the A regions. In the Saitama Prefecture areas, the frequency of ingestion of home-grown vegetables was higher in the B regions than in the A regions.

With respect to smoking history, there was more exposure to second-hand smoke (the exposed person being referred to here as “passive smoker”) in the B regions than in the A regions.

With respect to pregnancy and birth history (women only), no distinct difference in the number of pregnancies was observed among the regions in any of the three areas.

With respect to nursing, breast milk was given more frequently than artificial milk in the A regions of the Nose Town area than in the B regions.

Table 1-2. Questionnaire Survey Results Compiled by Area and Region

Questionnaire Item	Numerical Value of Response	Osaka Prefecture Nose Town Regions			Saitama Prefecture Regions			Hiroshima Prefecture Fuchu City Regions		
		A region	B region	Test <sub>2</sub> t	A1, A2 region	B region	Test <sub>2</sub> T	A region	B region	Test <sub>2</sub> T
Dietary habits	0.1: Eat rarely if ever									
Shore fish ingestion	0.35: 1 – 2 times per month	1.81	1.65		1.71	1.99		2.47	1.70	
Other fish ingestion	1.5: 1 – 2 times per week	1.21	1.80		1.79	1.26		1.91	1.00	
Beef ingestion	3.5: 3 – 4 times per week	1.46	1.72		0.96	0.78		1.39	1.36	
Pork ingestion	6: Nearly every day	1.83	1.59		1.81	1.80		1.45	1.08	
Chicken egg ingestion		2.97	3.75		3.91	2.83		4.13	4.84	
Milk ingestion		3.03	3.42		3.64	2.85		2.26	4.11	
Home-grown food ingestion	0: No home-grown food or chicken	3.12	4.58		1.96	4.72		3.86	4.84	
Ingestion of chicken eggs for home consumption	0.1: Eat rarely if ever	0.35	0.04		0.04	0.04		0.24	0.39	
	1.5: 1 – 2 times per week									
	3.5: 3 – 4 times per week									
	6: Nearly every day									
Smoking history										
Have/have not been primary smoker	1: Have been primary smoker	0.50	0.60		0.23	0.17		0.38	0.88	
	0: Have not been primary smoker	0.82	0.80		0.52	0.92		0.37	0.74	
Have/have not been passive smoker	1: Have been secondary smoker									
	0: Have not been secondary smoker									
Pregnancy & birth history (women only)										
Number of pregnancies		3.10	2.38		2.90	3.00		3.13	2.67	
Number of deliveries		2.36	2.00		2.37	2.63		2.43	2.11	
Nurse baby at home	1: Artificial milk      2: Mixed milk	2.64	1.75		2.19	2.13		1.88	2.22	
	3: Breast milk									

The figures in the table show mean values for each region derived from numerical values assigned to questionnaire responses.

A secondary smoker is a non-smoker who lives with a smoker or who is exposed to the smell of tobacco at the place of work.

The tests are t-tests or chi-squared tests.      is placed by items for which, two-tailed test showed a significant difference between A regions and B regions at 5% significance level

