A BIOMONITORING PROGRAM IN THE VICINITY OF A WASTE INCINERATION PLANT IN THE NETHERLANDS

De Kok, M.T.[A], Van Dijk, C.J.[B], Van Alfen, A.J.[B], Van der Eerden, L.J.M.[B]
[A] HASKONING Royal Dutch Consulting Engineers and Architects, P.O. Box 151, 6500 AD Nijmegen, The Netherlands
[B] DLO-Centre for Agrobiological Research, P.O. Box 14, 6700 AA Wageningen, The Netherlands

1. INTRODUCTION

In March 1992, HASKONING Royal Dutch Consulting Engineers and Architects started a biomonitoring program in co-operation with the DLO-Centre for Agrobiological Research (CABO-DLO) in The Netherlands. This program was developed on commission by a Waste Incineration Plant (WIP) in Alkmaar, The Netherlands. The objective of this program is to detect possible effects of the emissions by the WIP on the quality of agricultural products and vegetables in the vicinity of the WIP.

Essential aspects concerning the design and implementation of the biomonitoring program are the following:
- selection of compounds emitted by the WIP;
- selection of so-called "bio-indicators";
- selection of locations in the vicinity of the WIP where samples are taken;
- nature and frequency of sampling;
- evaluation of results.

2. MATERIALS AND METHODS

Selection of emitted compounds

Five of the compounds emitted by the waste incineration plant were selected on the basis of their potential harmfulness or toxicity to human beings, crops and cattle and their emission levels. These compounds are cadmium (Cd), mercury (Hg), fluorides (HF), polyaromatic hydrocarbons (PAH) and dioxins/furans (PCDD/PCDF)[1].

Selection of bio-indicators
The bio-indicators were selected on the basis of an extensive literature research, combined with scientific and practical knowledge of various environmental experts in The Netherlands[2,3]. The following parameters have been used to select the bio-indicators: sensitivity, selectivity, applicability, reliability, practicability and experience with the bio-indicator. Furthermore the relevance of the bio-indicator to the vicinity of the WIP was a major factor [in selecting the bio-indicators].

In view of the agricultural exploitation of the vicinity of the incineration plant, the following products have been chosen as bio-indicators[2]:
- spinach;
- kale;
- pasture grass;
- tulip/gladiolus;
- cow's milk.

Selection of locations
With the help of a dispersion model the locations near the WIP with the lowest and highest expected ambient air levels were identified. The area exhibiting minimum concentrations of the WIP was chosen as reference location and two locations in and near the maximum concentration were chosen as sites where possible harm can be assessed.

Nature and frequency of sampling
At the three locations the selected plants were cultivated in a standardized manner. These plants were visually examined after a fixed period of exposure. Afterwards the plants, except the tulips and gladiolus, were analyzed for one or more of the selected compounds. Furthermore, milk samples were taken from cows that had been grazing in the selected locations. These samples were analyzed for PCDD/PCDF by means of gas chromatographic-high-resolution mass spectrometric determination[4]. In table 1, shown below, an overview is given of the bio-indicators applied in relation to the selected compounds, the sampling frequency and the number of locations, during one year of experience with the biomonitoring program.

Table 1: Survey of the bio-indicators selected in relation to compounds, sampling frequency and number of locations

Indicator	Compounds	Sampling frequency	Number of locations
Spinach	Cd, Hg, PAH	3	3
Kale	Cd, Hg, PAH	3	3
Pasture grass	Fluorides[5]	13 (4-weekly)	3
Tulip/gladiolus	Fluorides	4 (visually)	3
Cow's milk	PCDD/PCDF	2	2

Evaluation of results
The results of the analyses were used to determine whether or not harmful effects had occurred. This is the case when the concentration of one or more of the selected compounds exceeds product limits or when harm is visually observed. Possible significant increases both in concentration and in impact at the locations with maximum ambient air concentration in comparison to the reference location were determined both through comparison and calculations. If a significant increase was measured, first the (continuously measured) emission pattern of the waste incineration plant was studied to investigate a possible relation between emission levels and concentration increases. Afterwards the analysis results were compared with certain product limits.
Whenever vegetation damage was observed which is suspected to be caused by air pollution from the WIP, diagnosis was performed by specialists on bioindication.

3. RESULTS AND CONCLUSION

Until now, no exceedance of product limits or obvious visual adverse effects on plants in the vicinity of the WIP in Alkmaar have been reported, neither at the two locations in the maximum concentration nor at the reference location. The concentrations analyzed are well below the product limits and most of the time near the background levels (Cd, Hg, fluorides, PAH). Only once a strongly increased PAH level in spinach was observed at one of the locations. The explanation for this increase however, appeared to be a farmers' shed that had been handled with a PAH containing wood preservative just a few days before sampling and in sunny weather. This explanation was confirmed as the next sample from new grown spinach, four weeks later, showed a background PAH level.

The results of the dioxin analysis in cow's milk from the two sample locations are shown in table 2. The average background level in The Netherlands, used as a reference value in the monitoring program, is 0.8 - 2.5 pg TEQ/g fat, the product limit amounts to 6 pg TEQ/g fat[6].
As can be concluded from this table, dioxin levels measured in the vicinity of the WIP Alkmaar are not significantly higher than the background level. Therefore the levels are far below the product limit of 6 pg TEQ/g fat.

4. REFERENCES

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Table 2: Dioxin levels in milk from cows in the vicinity of the WIP analyzed at two different dates in 1992

Component	TEF	Dioxin level, pg TEQ/g fat			
		Location 1		Location 2	
		week 24	week 40	week 24	week 40
2,3,7,8-TCDF	0.1	n.d.*	0.01	n.d.	0.01
2,3,7,8-TCDD	1	0.19	0.14	n.d.	0.07
1,2,3,7,8-PeCDF	0.05	n.d.	n.d.	n.d.	n.d.
2,3,4,7,8-PeCDF	0.5	0.41	0.54	0.35	0.57
1,2,3,7,8-PeCDD	0.5	0.09	0.21	0.18	0.30
1,2,3,4,7,8-HxCDF	0.1	n.d.	0.041	n.d.	0.042
1,2,3,6,7,8-HxCDF	0.1	n.d.	0.043	n.d.	0.042
2,3,4,6,7,8-HxCDF	0.1	0.048	0.057	n.d.	0.052
1,2,3,7,8,9-HxCDF	0.1	n.d.	n.d.	n.d.	n.d.
1,2,3,4,7,8-HxCDD	0.1	n.d.	0.021	n.d.	n.d.
1,2,3,6,7,8-HxCDD	0.1	n.d.	0.052	0.01	0.044
1,2,3,7,8,9-HxCDD	0.1	n.d.	n.d.	n.d.	n.d.
1,2,3,4,6,7,8-HpCDF	0.01	0.0026	0.0022	n.d.	n.d.
1,2,3,4,7,8,9-HpCDF	0.01	n.d.	n.d.	n.d.	n.d.
1,2,3,4,6,7,8-HpCDD	0.01	n.d.	0.0048	n.d.	0.0065
OCDF	0.001	n.d.	n.d.	n.d.	n.d.
OCDD	0.001	0.0023	0.0029	0.004	0.0017
Total TEQ		0.74	1.12	0.54	1.14

* n.d. = not detected (below detection limit)