ENVIRONMENTAL BASELINE LEVELS OF DIOXINS AND FURANS IN THE REGION OF OPORTO

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Introduction

In the municipal solid waste (MSW) management plan adopted for the metropolitan area of Oporto, in Portugal (see Figure 1) it was decided to build a MSW incinerator with the capacity of 400 000 ton.a^{-1} commonly refered as the LIPOR II project. Trial burns will be performed at LIPOR II during the Summer of 1999 and regular operation is foreseen for January 2000. An External Monitoring Plan (EMP) of LIPOR II has been designed with the objective of assessing the potential impact over the environment of the construction and operation of this facility. One of the main concerns of the EMP is to fulfill the lack of information about the environmental baseline levels of PCDD and PCDF prior to the operation of the MSW incinerator. This information is essential to assess the actual environmental impact of LIPOR II.

Description of the project

During 1998, the Institute of Environment and Development (IDAD) performed an extensive monitoring campaign of PCDD and PCDF levels in the region of Oporto. A set of 11 monitoring stations in a radium of approximatelly 10 km from the future incinerator were selected. A short description of the sites is summarized in Table 1. The majority of the monitoring stations are located near the incinerator in the suburbs of Oporto. The EMP also includes a station located in the center of downtown Oporto for the sampling of urban air as well as rural stations for the collection of agricultural material.

Additionally, 9 monitoring stations for river and underground water control and 5 monitoring stations for noise level control are also included in the EMP. Monitoring of the baseline levels will continue during the first semester of 1999.

Table 1 - Characteristics of the monitoring stations of the External Monitoring Plan of LIPOR II.

ID	Name	Distance (m)	Direction	Land-use	Matrices
B1	Agrela	2500	SE	Sub-urban	Biological material
B2	Gandra	1250	NNW	Rural	Biological material
B3	Gemunde	4500	N	Rural	Biological material
B4	Carvalhas	1000	S	Sub-urban	Biological material
B5	Pte. Cabreira	300	ESE	Sub-urban	Biological material
B6	Pte. Moreira	900	NNE	Sub-urban	Biological material
C1	Crestins	500	NNW	Urban	Air
C2	Porto	9750	SSE	Sub-urban	Air
L1	Pte. Moreira	900	NNE	River bed	Sediment
L2	Pte. Cabreira	300	ESE	River bed	Sediment
L3	Pte. Goimil	1250	SSE	River bed	Sediment

Results and Discussion

A total of 41 samples in several environmental and biological matrices are reported in the present paper. Tables 2 and 3 summarize the results obtained by the EMP. In these tables, congeners are represented by: 4D-TetraCDD, 5D-PentaCDD, 6D-HexCDD, 7D-HeptaCDD, 8D-OctaCDD, 4F-TetraCDF, 5F-PentaCDF, 6F-HexaCDF, 7F-HeptaCDF, 8F-OctaCDF and D/F represents the ratio between total PoliCDD and total PoliCDF.

Monitoring activities of PCDD and PCDF levels in the framework of the EMP can be split into 2 sub-programs: the environmental sub-program (Table 2) with samples of air, river sediments and soil; the biological sub-program (Table 3) including samples of cow feedstuff, composed mainly by rye-grass with oat, cabbage leafs, chicken eggs and cow milk.

Table 2 - Environmental levels of dioxin and furans in air, soil and sediment in Oporto.

ID	Date	Concentration					I-TEQ				
	1998	3 majour congeners			D/F	Total	3 majour congeners			D/F	Total
Ambient air samples (fg.m^{-3})											
C1	29-06	8D 76%	7D 12%	8F 5%	9.20	4843	5F 22%	6F 19%	6D 14%	1.04	**46.8**
C2	06-07	8F 33%	8D 26%	7F 14%	0.60	10139	6F 40%	5F 26%	6D 9%	0.30	**306.1**
C1	13-07	8D 33%	7D 16%	7F 13%	1.25	6332	7F 32%	5F 25%	6D 14%	0.52	**254.6**
C2	26-07	8D 43%	7F 13%	7D 12%	1.42	1562	6F 33%	5F 30%	6D 8%	0.36	**58.8**
C2	02-11	8D 54%	7D 16%	7F 7%	2.98	1443	5F 29%	6F 21%	5D 13%	0.66	**46.4**
C1	09-11	8D 56%	7D 14%	6F 7%	2.89	1129	5F 27%	6F 22%	5D 12%	0.63	**35.9**
C2	16-11	8D 62%	7D 16%	7F 6%	4.52	18743	5F 28%	6F 23%	6D 13%	0.69	**417.6**
C1	23-11	8D 60%	7D 19%	7F 5%	4.64	12084	5F 24%	6F 21%	6D 15%	0.88	**259.0**
C1	27-11	8D 64%	7D 19%	7F 4%	6.67	21134	5F 20%	5D 18%	6F 18%	1.27	**415.9**
C1	02-12	8D 61%	7D 18%	6F 5%	4.89	20344	5F 25%	6F 20%	6D 16%	0.88	**490.3**
C2	10-12	8D 45%	7D 15%	7F 11%	1.76	4005	6F 29%	5F 27%	6D 10%	0.48	**131.4**
C2	15-12	8D 60%	7D 17%	6F 5%	4.21	4605	5F 27%	6F 21%	5D 14%	0.75	**114.1**
Soil samples (ng.kg^{-1})											
B1	31-08	8D 80%	7D 18%	6D 1%	41.40	4354.8	7D 48%	8D 21%	6D 17%	10.92	**16.39**
B2	23-10	8D 67%	7D 14%	6D 7%	6.07	46.4	6D 35%	5F 19%	6F 14%	1.38	**0.85**
B3	09-10	8D 62%	7D 11%	6D 9%	4.90	28.5	6D 32%	5F 15%	6F 14%	1.73	**0.79**
B4	23-10	8D 81%	7D 11%	8F 3%	21.67	355.4	7D 20%	6D 19%	8D 14%	2.07	**2.04**
B5	01-09	8D 80%	7D 14%	8F 2%	39.47	881.8	7D 23%	6D 23%	8D 14%	2.77	**5.19**
B6	29-09	8D 82%	7D 11%	8F 3%	37.17	628.0	7D 21%	6D 17%	6F 13%	1.94	**3.24**
Sediment Samples (ng.kg^{-1})											
L1	06-04	8D 86%	7D 11%	8F 1%	3.99	154.2	7D 30%	8D 24%	6D 17%	2.60	**0.54**
L2	06-04	8D 90%	7D 7%	8F 1%	6.87	340.8	8D 30%	7D 25%	6D 21%	4.62	**1.01**
L3	06-04	8D 82%	7D 13%	8F 3%	45.84	1038.8	7D 39%	8D 25%	6D 15%	4.72	**3.39**

Table 3 – Biological levels of dioxin and furans in cabbage, rye-grass, chicken eggs and cow milk samples in the region of Oporto.

ID	Date 1998	Concentration					I-TEQ				
		3 majour congeners			D/F	Total	3 majour congeners			D/F	Total
Cabbage (ng.kg^{-1})											
B1	23-10	8D 56%	7D 8%	8F 7%	2.34	7.69	5F 27%	4D 22%	4F 16%	0.85	**0.37**
B2	29-09	8D 53%	7D 9%	8F 8%	2.56	7.86	5F 24%	4D 22%	5D 17%	0.92	**0.36**
B3	09-10	8D 53%	7F 10%	7D 9%	1.90	6.09	5F 29%	4D 17%	4F 17%	0.54	**0.24**
B4	01-10	8D 63%	7D 9%	8F 8%	3.21	6.74	5F 26%	4D 22%	4F 14%	0.87	**0.24**
Rye-grass (ng.kg^{-1})											
B1	31-08	8D 81%	7D 13%	8F 2%	19.67	136.14	7D 20%	5F 16%	6D 16%	1.80	**0.88**
B2	01-10	8D 68%	7D 14%	6F 4%	6.93	25.86	5D 25%	5F 18%	4D 15%	1.64	**0.65**
B3	28-10	8D 82%	7D 8%	8F 4%	11.32	55.34	5F 20%	6D 15%	6F 14%	1.35	**0.44**
B4	01-11	8D 71%	7D 16%	7F 3%	8.77	75.88	5F 21%	6F 16%	5D 16%	1.23	**1.28**
B5	01-09	8D 79%	7D 10%	8F 4%	10.39	53.20	6F 20%	5F 18%	6D 17%	1.22	**0.49**
B6	29-09	8D 83%	7D 7%	8F 6%	9.70	74.04	5F 17%	5D 15%	6F 15%	1.51	**0.54**
Chicken eggs (ng.kg^{-1})											
B1	05-11	5D 28%	8D 14%	7D 13%	1.90	34.78	5D 70%	5F 11%	6D 5%	4.17	**6.89**
B2	29-10	8D 41%	7D 22%	6D 10%	3.08	158.23	6D 21%	5F 21%	5D 20%	1.29	**7.72**
B3	29-10	6F 28%	5F 16%	6D 14%	0.53	59.16	5F 35%	6F 21%	5D 16%	0.57	**7.98**
B4	05-11	5F 24%	4F 20%	6F 12%	0.51	34.13	5F 39%	5D 19%	4D 17%	0.72	**5.80**
Cow milk (ng.kg^{-1})											
B1	23-10	7D 25%	6D 19%	8D 13%	2.29	20.19	5F 30%	4D 25%	5D 24%	1.60	**3.52**
B2	05-09	6D 19%	8D 16%	6F 15%	1.72	11.49	4D 31%	5D 26%	5F 25%	1.96	**2.52**
B3	29-10	8D 23%	6D 16%	6F 16%	1.65	7.86	5F 30%	4D 24%	5D 23%	1.42	**1.20**
B4	05-11	6F 19%	6D 18%	8D 16%	1.55	10.18	5F 32%	5D 24%	4D 22%	1.31	**1.79**

The analysis of ambient air levels measured within this program depict two significant characteristics: there isn't a significant difference between urban and sub-urban concentrations; a temporal plot of the results would show the occurrence of 1-2 weeks high level regional episodes, with 72 hour average concentrations above 400 $fg.m^{-3}$. These results suggest the existence of important sources of PCDD and PCDF as previously shown in an emission inventory[1] developed for the region.

Soils samples showed low levels of PCDD and PCDF with the exception of site B1, where concentration was in the typical range of urban areas. An important peak of HeptaCDD was found in this sample. PCDD and PCDF levels in the river Leça sediment were in the range between 0.54 and 3.39 $ng.kg^{-1}$. Comparison of samples L2 and L3 evidentiate and increase of concentration downhill, caused by the presence of significant amounts of highly chlorinated dioxins.

The 4 samples of cabbage leaves analysed in this monitoring program showed very similar results either in the total concentration levels as well as in the congener distribution. Rye-grass samples indicate PCDD and PCDF levels between 0.44 and 1.28 $ng.kg^{-1}$. Animal matter samples were taken both in chicken eggs and cow milk. Eggs samples showed high levels of PCDD and PCDF with values between 5.80 and 7.98 $ng.kg^{-1}$ fat. These values are consistent with levels found[2] on chickens kept on ground. Congener structure for site B1 show a hich level of PentaCDD. High levels were also found in the cow milk samples with values between 1.20 and 3.52 $ng.kg^{-1}$.

Conclusions

This paper presents the first results of PCDD and PCDF levels published for Portugal. The monitoring of the baseline levels will continue through the first semester of 1999. The activities developed within the EMP are essential to be able to assess the actual environmental impact of LIPOR II.

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