

# Dioxin '97, Indianapolis, Indiana, USA

## Environmental levels of PCDD/DFs and PCBs in the Panteg District of South Wales, UK and their implications for human exposure

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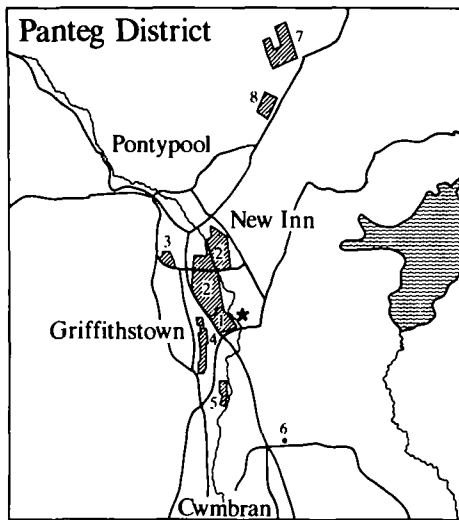
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### Introduction

A comprehensive investigation of environmental concentrations of PCBs and PCDD/DFs was carried out in the Panteg district of south Wales between 1991 and 1995<sup>1,2</sup>. The research was primarily a response to public concern regarding the operations of an incinerator handling PCB waste owned by Rechem International Ltd and represented the most extensive study of its type ever conducted in the UK. A particular feature of the work was the wide range of environmental compartments sampled for both PCBs and PCDD/DFs. These included soil, river sediment, grass, air, milk, vegetables, fruit, eggs and poultry meat. To our knowledge, the collection and analysis of such a diversity of samples from specific locations is unprecedented. This paper therefore summarises our overall findings on geographical variations in environmental levels and then assesses the implications for human exposure.

### Methods

Samples were collected in the main residential areas and around a number of industrial or combustion facilities in the Panteg district (see Figure 1). For fruit, vegetables, eggs and poultry meat it was also necessary to obtain information on background concentrations of PCBs and PCDD/DFs by undertaking sampling in several rural areas of Wales and England. Full details of the sample collection, preparation and quality control procedures have been presented elsewhere<sup>1,2,3,4</sup>. Table 1 summarises the numbers of samples analysed for each environmental compartment and indicates the extensive nature of the monitoring programme. All the PCDD/DF analyses were based on the seventeen 2,3,7,8 substituted congeners, but for PCBs the situation varied. A minimum of seven PCB congeners (28, 52, 101, 118, 138, 153 and 180) were determined for all samples, but for fruit and vegetables the number was extended to eighteen, and for eggs and poultry meat it was increased to forty six. The latter reflected recommendations by the UK Department of Health for the assessment of PCB toxicology<sup>5</sup>.



### Key to Map Symbols

- Principal Roads
- Rivers & Llandegfedd Reservoir

- 1 Rechem International
- 2 Industrial Estates
- 3 County Hospital
- 4 Avesta (Sheffield)
- \* Pontyfelin House
- 5 Pilkington Insulation
- 6 Gwent Crematorium
- 7 ICI
- 8 Warner Lambert

**Figure 1:** Locations within the Panteg District.

**Table 1:** Samples collected during the Panteg Monitoring Project, 1991-1994.

Sample Type	Number of Samples		
	PCBs	PCDD/DFs	Total
Air: Hi-vol	35	23	58
Air: Deposit Gauge	24	12	36
Soil	140	42	182
Sediments	13	6	19
Grass	13	11	24
Milk	24	16	40
Fruit/Vegetables	53	40	93
Poultry Feed	10	7	17
Eggs	27	27	54
Poultry Meat	8	8	16
<b>Totals</b>	<b>347</b>	<b>192</b>	<b>539</b>

### Results

Data from the monitoring programme indicated particular PCB and PCDD/DF contamination in a strip of land some 200 metres wide around the eastern boundary of the incineration plant and encompassing the smallholding at Pontyfelin House (see Figure 1). This property is in the predominant downwind direction from the incinerator and there was evidence to suggest that fugitive (rather than stack gas) emissions from the plant were responsible for the environmental contamination. No comparable areas of PCB or PCDD/DF contamination were found elsewhere in the Panteg district and there was a tendency for levels to decline with increasing distance from the eastern side of the incineration plant<sup>1,2</sup>.

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Table 2 summarises the variations in PCB levels by presenting median concentrations for different types of samples collected at Pontyfelin House; within the partially urban Panteg district; and at predominantly rural background locations. The latter values are based on a mixture of results from the Panteg Monitoring Project and information from other national surveys<sup>6,7,8,9</sup>. Several cells within the table are blank because some types of samples could not be collected from particular locations, but the general difference in levels between Pontyfelin House and the other two categories is evident. A similar trend is apparent in the results for PCDD/DFs in Table 3, emphasizing the strong correlation between PCB and PCDD/DF concentrations in the samples<sup>10</sup>.

**Table 2: Total PCB concentrations in samples from different locations.**

Sample Type	Median Concentration		
	Pontyfelin House	Panteg District	Background
Milk	-	-	-
Duck Eggs	232	14	5.3
Bantam Eggs	428	-	16
Chicken Eggs	-	6.7	6.6
Duck Meat	20	-	13
Apples	14.3	2.6	1.8
Lettuce	-	1.5	2.3
Potatoes	-	2.2	1.3
Air	5.1	1.0	0.5
Soil	330	100	20

Note: The units are: food,  $\mu\text{g}/\text{Kg}$  fresh mass; air,  $\text{ng}/\text{m}^3$ ; soil,  $\mu\text{g}/\text{Kg}$  dry mass.

**Table 3: PCDD/DF (I-TEQ) concentrations in samples from different locations.**

Sample Type	Median Concentration		
	Pontyfelin House	Panteg District	Background
Milk	-	-	-
Duck Eggs	3.8	0.95	0.8
Bantam Eggs	12.0	-	0.6
Chicken Eggs	-	1.0	1.2
Duck Meat	1.0	-	0.4
Apples	0.7	0.4	0.3
Lettuce	-	0.3	0.3
Potatoes	-	0.4	0.3
Air	0.77	0.16	0.22
Soil	112	19	6.3

Note: The units are: food,  $\text{ng TEQ}/\text{Kg}$  fresh mass; air,  $\text{pg TEQ}/\text{m}^3$ ; soil,  $\text{ng TEQ}/\text{Kg}$  dry mass.

## Exposure Assessment

PCBs and PCDD/DFs have been found in practically all compartments of the ecosystem<sup>11</sup>. Humans may be exposed through inhalation of contaminated air, ingestion of polluted agricultural produce or soils, and through skin contact with materials containing PCBs or PCDD/DFs. The food chain is thought to be the primary pathway of exposure and since PCBs and PCDD/DFs are highly lipophilic in nature, those foodstuffs high in fats or oils (such as eggs) represent the major source of human dietary intake<sup>12</sup>. Given the results summarised in the previous section, it was therefore thought important to quantify the extent to which residents of the Panteg district were exposed to higher levels of PCDD/DFs and PCBs than those living in more rural locations and to assess whether any regulatory action might be necessary.

Using mean daily consumption rates for the various foodstuffs<sup>2</sup>, inhalation and soil ingestion rates of 20m<sup>3</sup>/day and 100mg/day respectively, and the median concentrations from Tables 2 and 3, estimated intakes of PCBs (µg/day) and PCDD/DFs (pg TEQ/day) were calculated. Details of the latter are presented in Table 4.

**Table 4:** Estimated intake of PCDD/DFs (pg/TEQ/day) from the consumption of food, ingestion of soil, and inhalation of air, at different locations.

Sample Type	Consumption Kg/Person/day	Estimated Intake (pg/TEQ/day)		
		Pontyfelin House	Panteg District	Background
Milk	0.303	-	36	15
Duck Eggs	0.027	103	26	22
Bantam Eggs	0.017	204	-	10
Chicken Eggs	0.027	-	27	32
Duck Meat	0.017	17	-	6.8
Apples	0.032	22	13	9.6
Lettuce	0.0058	-	1.7	1.7
Potatoes	0.151	-	60	45
Air	20m <sup>3</sup> /day	12	2.4	3.3
Soil	100mg/day	11	1.9	0.6

Scrutiny of these results suggests that the various PCDD/DF intakes for the Panteg district differ little from those at background locations. In contrast, estimated exposures to PCDD/DFs at Pontyfelin House are substantially above background levels, with the major contributions being from bantam and duck eggs. On a comparative basis, poultry meat, apples, air and soil represent minor sources of PCDD/DF intake at Pontyfelin House. Similar trends are apparent in the estimated intakes of PCBs..

The ingestion of bantam or duck eggs from Pontyfelin House at normal rates of consumption would result in estimated PCDD/DF intakes of 204 pg TEQ/day and 103 pg TWQ/day respectively, levels that are substantially higher than the average UK dietary intake of 88 pg

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TEQ/day from all food sources<sup>13</sup>). Calculated on a body mass of 60 Kg, these egg intakes (i.e. 3.4 and 1.7 pg TEQ/Kg body mass/day) would in themselves represent 34 % and 17 % of the WHO TDI value of 10 pg TEQ/Kg body mass<sup>14</sup>). The corresponding PCB intakes of 7.3 and 6.3 µg/day would constitute 73 % and 63 % respectively of an average dietary intake (10 µg/day) of this contaminant<sup>15</sup>).

In view of the high levels of PCBs and PCDD/DFs found in duck and bantam eggs from Pontyfelin House, the owners of the property have been advised by the Welsh Office not to consume such produce.

## Conclusions

The results of this study indicate that there were marked differences in PCB and PCDD/DF concentrations between Pontyfelin House and sites elsewhere in the Panteg district across a wide variety of environmental compartments. Bantam and duck eggs were identified as the major sources of exposure and, if consumption of these foodstuffs had taken place, would have represented substantial proportions of typical dietary intakes for PCBs and PCDD/DFs. Since the start of the Panteg Monitoring Project substantial modifications have been made to the waste incinerator, and routine monitoring of the operation of the facility is continuing under the supervision of the Environment Agency.

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