CHANGES TO THE TEF SCHEMES CAN HAVE SIGNIFICANT IMPACTS ON REGULATION AND MANAGEMENT OF PCDD/F

Patrick H Dyke.

PD Consulting, Round House Cottage, Downington, Lechlade, GL7 3EE, UK

Introduction

Important changes in the assessment and management of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) may be required by Governments in response to the recent recommendation by the WHO for a revision to the Tolerable Daily Intake of PCDD/F and the extension to include "dioxin-like" polychlorinated biphenyls (PCB) [1]. These days most policy decisions related to PCDD/F are dependent on the use of toxic equivalency systems and the use of toxic equivalent concentrations (TEQ) as a simplification to deal with a complex mixture of compounds. The application of TEF schemes to PCB is only now becoming established.

In the UK a review is under way to assess needs for revisions to UK policy on PCDD/F and on addressing "dioxin-like" PCB. One part of the review was to examine the whether the adoption of the revised scheme of TEFs published by WHO[2] (as applied to mammals) would make any significant difference to the interpretation of data in the UK. Over the past decade the UK Government and regulators, in common with many other Agencies and researchers world-wide, have used the International TEF (I-TEF) scheme.

The changes are an increase in the TEF for 1,2,3,7,8-PeCDD from 0.5 to 1 and a decrease in TEFs for OCDD and OCDF from 0.001 to 0.0001. The WHO scheme includes TEFs for selected PCB, where comparisons are made which include PCB the comparison is against the older scheme in use in the UK (proposed by Ahlborg[3])

Methods

Existing data sets covering emissions, environmental concentrations, food levels and exposure were gathered and assessed. Where data sets providing congener specific analysis were available these were processed to give results in I-TEQ and WHO TEQ. The change between them was expressed as a % increase or decrease from the I-TEQ value. In general non-detects have been set to zero. The data sets were drawn from a variety of sources but only represent a small sub-sample of all the possible sets so different impacts can be expected on other results. In many cases full congener specific data may not be available, in particular data sets containing analysis of the "dioxin-like" PCB congeners are rare. In this paper results from changes to the TEF scheme for PCDD/F are presented.

Results and Discussion

Many data sets were not presented with congener specific data and therefore it was not possible to assess the impacts of the revised TEF schemes. Example data sets are presented and discussed.

Changes to the TEQ values (PCDD/F) of releases to air from a variety of processes are listed in Table 1. Nearly all the data sets examined showed an increase in TEQ moving from the I-TEQ to the WHO TEQ. Average increases appear relatively small (up to 10%) for well

controlled sources, there is some indication that animal carcass incineration and crematoria show larger increases (c 20%) due to higher amounts of 1,2,3,7,8 – PeCDD present. Cement kilns showed significant variability in the impact of the changes (ranging from a drop of 54% to an increase of 32%). Such changes may materially influence the achievement of an emission limit.

For sludges (Table 1) several results showed significant reductions due to the higher levels of OCDD and OCDF in the samples. Sewage sludge regulations may be expressed in TEQ and these changes may alter classification and use of sludge.

Table 1 Changes to TEQ (PCDD/F) of Selected Sources

Source		Range of % changes (relative to I-TEQ)	Mean % change (relative to I-TEQ)	Reference
Air emissions	Municipal waste incineration	-2 to +18%	+7.6%	UK regulatory data (27 tests)
	Sewage sludge incineration	-	+1.4%	US EPA (average profile)
	Hazardous waste incineration	-0.2% to +13%	+6.8%	UK regulatory data (12 tests)
	Cement kilns	-55 to +32%	+4.5%	UK regulatory data (17 tests)
	Barrel burning of household waste	-	+11.6%	US EPA tests
	Animal carcass incineration	+15 to +25%	+19.4%	UK regulatory data (4 tests)
	Crematoria	+19 to +21%	+19.9%	UK tests (4 runs, 2 plants)
Sludges	Sewage sludge (US)	-	0.85%	US EPA inventory
	Sewage sludge (UK average of 8 sites)	-	-18.5%	
	Sludge from chlorine chemical industry plant	-72% to +4.5%	-32%	Private data

Three congener specific analyses for PCP (Table 2) showed substantial reductions in the calculated TEQ ranging from 34 to 68% due to the predominance of OCDD. This will make significant changes to estimates of PCDD/F as TEQ linked to the use of PCP.

Table 2 Change to TEQ of Samples of PCP

Source	I-TEQ	WHO TEQ (PCDD/F)	% change	Reference
PCP (1985)	4.4 mg/kg	2.9 mg/kg	-34%	European Commission Study (DGIII 1997)
PCP (1986)	2.7 mg/kg	1.7 mg/kg	-38%	
PCP (1988)	4.1 mg/kg	1.5 mg/kg	-64%	

Levels in foods from the UK diet survey (Table 3) which comprises composites of food groups showed larger changes with the TEQ (PCDD/F) generally increasing (by up to 25%). Data were available on PCB in food and the change to the TEF scheme led to reductions in TEQ (PCB) of up to 14% (fish).

Table 3 TEQ Changes for Selected UK Food Samples (PCDD/F)

Food type	I-TEQ (ng TEQ/kg fresh)	WHO TEQ (ng TEQ/kg fresh)	% change	Reference
Carcass meat 1992	0.11	0.14	26%	UK Ministry of Agriculture Fisheries and Food studies
Meat products 1992	0.069	0.076	10%	
Poultry 1992	0.092	0.11	15%	
Fish 1992	0.19	0.23	17.5%	
Oils and fats 1992	0.19	0.21	15%	
Eggs 1992	0.17	0.19	12%	
Milk 1992	0.047	0.055	17%	
Milk products 1992	0.16	0.19	18%	
Bread 1992	0.0079	0.0059	-25%	

Table 4 UK Dietary Exposure in pg TEQ/kg bw/d (1992 – MAFF)

		I-TEQ			WHO TEQ		
		PCDD/F	PCBs	Total	PCDD/F	PCBs	Total
Adults	Average consumer	1.5	0.9	2.4	1.6 (+7%)	0.90 (0%)	2.5 (+4%)
	High level consumer	2.6	1.7	4.2	2.8 (+8%)	1.6 (-6%)	4.3 (+2%)

Overall exposure to UK consumers via the intake of food (Table 4 shows adult exposure) was found to increase for all exposure groups due to an increase in the TEQ from PCDD/F overriding a smaller decrease in TEQ from PCB.

Conclusions

Changes to the TEF scheme proposed by WHO appear minor but can have a large impact on the resulting TEQ of sources, environmental levels and exposure. This in turn could affect regulatory decision making, source ranking and interpretation of data.

Emissions to air generally appear to increase when expressed as TEQ using the WHO scheme compared to the I-TEF scheme. Samples dominated by higher chlorinated congeners may decrease significantly – for example some sludges and pentachlorophenol.

If regulatory limits are expressed as TEQ concentrations the change to the TEF scheme may have important implications. Furthermore, overall inventories may be affected by the change – for example the flow of PCDD/F in PCP is likely to be reduced substantially.

Whilst it is common for researchers to present data expressed as TEQ they do not always specify the scheme applied nor present results using the alternative scheme, this would improve the usefulness of the data considerably.

The changes to the TEF scheme for PCB are less significant (when compared to the TEF scheme recommended in the mid 1990s). However, in many cases PCB have not been included at all in the analysis of samples and emissions and their inclusion can have a significant affect on the overall TEQ.

Acknowledgements

The author wishes to thank the DETR for financial support for this work and Dr Jane Stratford for comments and guidance in the paper preparation. The opinions expressed in this paper are those of the authors and do not necessarily reflect those of the DETR.

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