Compilation of EU Dioxin Exposure and Health Data Task 9 – Generic Issues

Report produced for

European Commission DG Environment

UK Department of the Environment, Transport and the Regions

October 1999

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Title	Compilation of EU Dioxin Exposure and Health Data
Customer	European Commission DG Environment and UK Department of the Environment, Transport and the Regions
Customer reference	97/322/3040/DEB/E1
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File reference	j:/dioxins/t9_generic/tsk9final
Report number	AEAT/EEQC/0016.9
Report status	Final

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Executive Summary

A very brief assessment has been made of a range of issues which are of general relevance to a number of Tasks within the study. These relate, primarily, to data generation, reporting and interpretation. Assessing the concentrations of dioxin in the various environmental media and other matrices across the EU Member States, and any observed trends, has proved to be particularly difficult because of wide variations in the sampling strategies employed by the different monitoring/research groups involved. In addition, the reporting of analytical data often provides inadequate or insufficient information for comparisons to be made between different data sets. It is clear that the value to the broader research community, as well as to policy makers, of the data generated could be greatly enhanced if a number of straightforward procedures were followed.

The following recommendations are made on the basis of this assessment:

- further work is required on the inter-calibration of dioxin laboratories in order to ensure consistent results across Europe;
- guidelines/standards are required for environmental sampling, data generation and reporting, which are comparable to the CEN standard for analysis, and which would greatly improve the comparability of results;
- an improved understanding is required of the significance of climate, agricultural practices and dietary regimes to dioxin exposure in Southern Member States of the EU, which differ from those of the Northern Member States. Such information is necessary to ensure that any future policies aimed at reducing exposure to dioxins are relevant and applicable throughout the European Union;
- governmental agencies, research institutions and private laboratories should be encouraged to make data relating to dioxin concentrations in environmental media and other matrices more widely available, in order to facilitate a more informed debate on the strategic options for reducing human exposure.

Contents

1 Introduction

The aim of this Task was to make a brief assessment of the range of issues that were of general relevance to a number of the Tasks within the project. These are summarised in the following sections, with a number of specific recommendations as to how improvements might be made in the future. These issues relate, primarily, to data generation and reporting, as a lack of consistency in these areas has led to difficulties in the compilation and comparison of data in a number of the individual Tasks.

A related issue is the interpretation of the data collected. An understanding of the limitations of data is important in order that any statistical analysis can be made at a suitable level. Sampling strategies and uncertainties are also discussed.

This study has collected and collated data from countries across the EU, spanning wide climatic and cultural differences. These factors also are considered as important influencing or confounding factors when drawing conclusions from the available data.

2 Dioxin analysis procedures and reporting

2.1 DATA GENERATION AND REPORTING

The comparability of two or more data points is essentially determined by two key factors: sampling strategies and analytical procedures. These issues are common to many scientific studies, but are of particular relevance here as there is such variation in quality across dioxin research data. A number of straightforward procedures should be followed in order to increase the value of individual sampling programmes for the wider research community. These include the following:

- Sampling strategies should be well defined and reported.
- Locations of sample points should be well characterised and information provided on sources of contamination, thus enabling a data analyst to confirm that they are comparing like with like.
- Sample volumes should be large enough to provide an adequate quantity of material for analysis. This may require that small samples are pooled. However, the use of pooling will conceal much of the variability in dioxin concentrations across an area or population of interest, and therefore should not be used if such information is required.
- The number of samples should be large enough to allow statistical analysis of the results, if this is required.
- The timing of taking the samples may be important because of seasonal variations in concentrations, such as in air and vegetation.

- All other variables relevant to the sample should be provided. These will vary according to type of location and the medium being sampled. For example, depth of core for soil and sediments, method of collection for air, length of growing season for vegetation.

2.2 DIOXIN ANALYSIS

Great improvements in analytical capabilities have occurred over the last two decades, resulting in increasingly accurate dioxin analysis. The limits of detection have decreased and, therefore, levels of uncertainty have also decreased. These improvements are welcomed, but can also cause problems for the comparison of reported data from different time periods. Care must be taken to compare like with like.

Before high-resolution mass spectrometers were available, dioxin and furan concentrations were reported on a homologue basis, ie total dioxins or total furans. Since the late 1980s, individual congeners have been detectable but, initially, often only the most toxic, 2,3,7,8-TCDD, was reported. Dioxin results are now generally summarised as total Toxic Equivalents (TEQ), using Toxic Equivalency Factors (TEFs) based on the toxicity of each of the congeners relative to 2,3,7,8-TCDD (See Task 8 – Human Toxicology). The TEF values have changed through time to reflect improvements in the understanding of the relative toxicity of the individual congeners.

Many laboratory inter-comparisons run by the various national and international institutions/organisations, as well as privately organised comparative studies, have generated a pool of experienced laboratories around the world which maintain high standards and precision. However, variations still exist between laboratories, requiring that further inter-calibration should be undertaken. It is good practice to use certified reference materials and standards for calibration. Laboratories should include quality control samples in each series of measurements and participate in inter-laboratory exercises.

Further standardisation of procedures is possible through the application of the European CEN Standard 1948 (1997) which at present is only required for the analysis of hazardous waste emissions. This standard covers sampling, extraction and clean-up as well as identification and quantification of congeners. However, it does not cover environmental sampling procedures or data reporting. A working group of the International Standards Organisation (ISO) is currently working on a dioxin analysis standard more generally applicable across various media.
The procedures which should be followed in the analysis and quantification of dioxins include the following:

- Details should be provided of the TEF scheme used and congener specific data provided wherever possible. This allows for conversion between different TEF systems. For new analysis it is recommended that the most recent WHO-TEFs are used, as these are based on the most up-to-date review of dioxin and furan toxicity.
- The limits of detection should be stated and a standard approach established for calculating TEQ regarding non-detects. It is recommended that this should include the provision of both the upper bound estimate (where non-detects are equal to the limit of

detection) and the lower bound estimate (where non-detects are equal to zero) of TEQ, in order to give a good indication of the reliability of the results.

- The fat content of food stuffs and other samples of animal origin should be stated with results and, similarly, organic matter and/or water content of abiotic samples are required in order that comparisons can be made between samples of different composition. There is a need for a consistent method of determination of these components of samples, especially for the fat content of foods.
- Wherever possible, statistical confidence intervals based on inherent analytical variability should be given. Knowledge of the known degree of accuracy of the analytical procedures provides more information on the quality of the data.

3 Data Interpretation

Problems with data comparability often limit the opportunities to undertake statistical analysis of data across more than one study. This means that it is difficult to draw significant conclusions from a large set of data across a single country or make inter-country comparisons. Inferences can be drawn concerning the pattern of the data, but these cannot be demonstrated statistically

Simple statistical summaries are often made, such as calculating the mean, median and standard deviation of a data set, and care is required when combining data that has already been summarised in this way. The use of percentiles to indicate the range of values in a data set is often preferable to standard deviation, because of the skewed nature of many distributions. This is particularly useful for exposure calculations, when it is often the highest values, such as those in the 95^{th} percentile, that are of concern and that need to be identified accurately. The average daily exposure is not a very useful measure of the exposure risk to the whole population because this does not provide information on the distribution of exposures across the population.

Variations in TEF systems were not considered to be an important factor in the data analysis undertaken in this study. Uncertainty due to other factors, such as how representative the samples were of a whole country, and analytical variations through time, caused much greater concern. However, in future, when other uncertainties have been reduced and as concentrations of the various congeners also fall, the TEF scheme will be an important factor for comparability. The standard reporting of congener specific data will aid conversions between different TEF systems.

As with many environmental issues, there is still a considerable amount of uncertainty concerning the characteristics of dioxins in the environment. This uncertainty is related to a lack of understanding of natural processes and, therefore, prevents a full explanation of the patterns that can be found in even the best quality data sets. Coupled with this, as has already been emphasised, there is a lack of reliable data due to analytical variation and incomplete reporting of results. This uncertainty should be borne in mind when conclusions are drawn from the data.

4 Geographical variations

This study of the environmental concentrations of dioxins and human exposure across the European Union has attempted to consider the influence of geographical variations; in particular, climate differences which might affect environmental processes, different agricultural practices, industrial development and dietary regimes. However, it was found that there is a general lack of information on the Southern European countries and, therefore, an analysis of geographical trends has not been possible.

It is recommended that further work is undertaken to better characterise the issues concerning dioxins and dioxin-like PCBs in Southern Member States; including an improved understanding of the significance of climate, agricultural practices and dietary regimes which differ from those of the Northern Member States. This might draw upon the existing network of research organisations across Europe. Such information is necessary to ensure that any future policies aimed at reducing exposure to these compounds are relevant and applicable throughout the European Union.

Geographical variations in the levels of contamination at background sites are also important, as is the actual definition of these sites. For example, a rural location in Ireland or Northern Sweden is likely to show much lower concentrations of background contamination than a rural location in Germany or the Netherlands, because of the overall density of population and industrialisation. This causes problems when trying to define the range of background concentrations across the EU.

Geographical variations can become blurred, through the transportation of goods around Europe or imports of goods from outside the region. This is particularly important for foods and animal feedstocks. Care should, therefore, be taken in the identification of the sources of these products before conclusions are drawn concerning sources of contamination.

5 Conclusions and Recommendations

Many environmental monitoring and research programmes relating to dioxins are undertaken each year within the EU. The value of the data generated to the broader research community, as well as to policy makers, could be greatly enhanced if a number of straightforward procedures were followed during data generation, analysis and reporting.

The following recommendations are made on the basis of this assessment:

- further work is required on the inter-calibration of dioxin laboratories in order to ensure consistent results across Europe;
- guidelines/standards are required for environmental sampling, data generation and reporting, which are comparable to the CEN standard for analysis, and which would greatly improve the comparability of results;
- an improved understanding is required of the significance of climate, agricultural practices and dietary regimes to dioxin exposure in Southern Member States of the EU, which differ from those of the Northern Member States. Such information is necessary to ensure that any future policies aimed at reducing exposure to dioxins are relevant and applicable throughout the European Union;
- governmental agencies, research institutions and private laboratories should be encouraged to make data relating to dioxin concentrations in environmental media and other matrices more widely available, in order to facilitate a more informed debate on the strategic options for reducing human exposure.

6 References

CEN 1948 (1997): Stationary Source Emissions – Determination of the mass concentration of PCDDs/PCDFs, Parts 1-3. CEN, European Committee for Standardisation, Brussels, Belgium

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