REPORT OF THE MEETING TO PEER REVIEW "THE INVENTORY OF SOURCES OF DIOXIN IN THE UNITED STATES"

—Final Report—

Prepared for:

National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460

EPA Contract No. 68-D5-0028
Work Assignment No. 98-05

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August 7, 1998

NOTE

This report was prepared by Eastern Research Group, Inc., an EPA contractor, as a general record of discussion during the peer review meeting. As EPA requested, this report captures the main points of scheduled presentations and highlights group discussions. This report does not record all details discussed, nor does it embellish, interpret, or enlarge upon matters that were incomplete or unclear. EPA will use this report as a basis for additional study and work on developing a comprehensive inventory of sources of dioxin in the United States. Except as specifically noted, no statements in this report represent analyses or positions of EPA.

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LIST OF ABBREVIATIONS

APCD	air pollution control device
BDD	polybrominated dibenzo-p-dioxin (also called PBDD)
BDF	polybrominated dibenzofuran (also called PBDF)
CARB	California Air Resources Board
CD	compact disk
CDD	polychlorinated dibenzo-p-dioxin (also called PCDD)
CDF	polychlorinated dibenzofuran (also called PCDF)
DOE	Department of Energy
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
ESP	electrostatic precipitator
HWI	hazardous waste incinerator
MACT	maximum achievable control technology
MSWI	municipal solid waste incinerator
MWI	medical waste incinerator
NCEA	National Center for Environmental Assessment
OAQPS	Office of Air Quality Planning and Standards
ORD	Office of Research and Development
OSW	Office of Solid Waste
PBDD	polybrominated dibenzo-p-dioxin (also called BDD)
PBDF	polybrominated dibenzofuran (also called BDF)
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin (also called CDD)
PCDF	polychlorinated dibenzofuran (also called CDF)
PCP	pentachlorophenol
PVC	polyvinylchloride
RDF	refuse-derived fuel
SAB	Science Advisory Board
TEF	toxic equivalency factor
TEQ	toxic equivalent
UK	United Kingdom
WHO	World Health Organization

EXECUTIVE SUMMARY

After reviewing the April 1998 external review draft of "The Inventory of Sources of Dioxin in the United States," five peer reviewers made the following main findings and recommendations. Specific examples of these findings and recommendations can be found throughout the body of the report. Overall, the reviewers found the inventory report (as summarized in Chapter 2) to be well written, comprehensive, and well documented, and they agreed that the dioxin emissions inventory marks a substantial advance in the understanding of dioxin sources. The reviewers found the "emission factor approach" used to develop the inventory to be scientifically defensible. The inventory clearly reflects a substantial amount of work, and the reviewers congratulate EPA on its efforts. After making recommended clarifications and revisions, EPA should complete the inventory and release it as part of the Dioxin Reassessment. The reviewers' main findings and recommendations are:

- New, unsuspected dioxin sources and additional data for known sources may be found. EPA should more prominently acknowledge in the general findings of the report and in summaries of the inventory that finding such sources and data could significantly alter the understanding of dioxin sources.

- Many of the potentially largest dioxin sources were not identified in previous U.S. dioxin emissions inventories. EPA should highlight these new sources in its general findings of the inventory, even though emissions from these sources are at present poorly quantified.

- The general findings of the report should have greater emphasis on the large amounts of dioxins in products, some of which have been quantified for the first time and none of which have quantified releases to the environment.

- By not including emissions estimates from all known sources of dioxins, the summary of the inventory report (Chapter 2) presents a potentially misleading picture of the results of the emissions inventory. EPA should revise the summary to provide a more balanced portrayal of all dioxin sources, including those that are difficult to quantify.

- EPA should take a less conservative approach for including emissions data, especially those from foreign countries or the non-peer-reviewed literature. The reviewers thought EPA could use these data sources and account for their uncertainties by assigning appropriate confidence levels to the corresponding release estimates.

- The confidence rating scheme and the corresponding uncertainty ranges are arbitrary and do not necessarily reflect the uncertainty in the emissions estimates. The reviewers recommend adding two "level of confidence" categories to the subjective rating scheme to better reflect the potential uncertainties and to provide a more informative portrayal of the emissions estimates. The reviewers also recommend that EPA present emissions data with qualitative, but not quantitative, estimates of uncertainty.

1.0 INTRODUCTION

This report summarizes the expert peer review of the April 1998 external review draft of "The Inventory of Sources of Dioxin in the United States," published by the Office of Research and Development (ORD) of the U.S. Environmental Protection Agency (EPA) (USEPA, 1998a). Five reviewers participated in the public peer review meeting, which took place in Alexandria, Virginia, on June 3–4, 1998. Eastern Research Group, Inc. (ERG), a contractor to EPA, organized the expert peer review and prepared this summary report. This introductory section provides background information on several topics relevant to this report, including the history of EPA's efforts to compile an inventory of dioxin emissions, the scope of the peer review of the emission inventory, and the organization of this report.

1.1 Background

Since 1992, EPA's National Center for Environmental Assessment (NCEA) has been reassessing the extent of human exposure to, and the health affects associated with, dioxin and dioxin-like compounds. The initial research on this topic culminated in 1994 when NCEA prepared and released a draft report titled "Estimating Exposure to Dioxin-Like Compounds" (USEPA, 1994). The second volume of the 1994 draft report identifies known sources of dioxins in the United States and estimates the quantities of dioxins that these sources release to the environment. EPA solicited feedback on the draft report, both from the public and from a formal peer review conducted by the Agency's Science Advisory Board (SAB).

Since the peer review of the 1994 draft report, EPA has revised the emission inventory document by addressing selected comments from the initial review, incorporating more recent estimates of dioxin emissions from industrial sources, and establishing specific time frames (i.e., the baseline years 1987 and 1995) for the emissions estimates in the inventory. EPA has also prepared an extensive dioxin emissions database, titled "Database of Sources of Environmental Releases of Dioxin-like Compounds in the United States," which is available on compact disk (CD) (USEPA, 1998b). Recognizing that some of these revisions have led to very significant changes to the inventory structure and to the emissions estimates, EPA decided to conduct a peer

review on the revised report, which was released as an external review draft in April 1998. The remainder of this report describes the scope and schedule of this latest peer review as well as its findings.

1.2 Scope of the Peer Review

To thoroughly review the comprehensive emission inventory document, EPA requested that ERG select five peer reviewers who were engineers or senior scientists with demonstrated expertise in any combination of the following areas:

- National databases of emissions from human and natural sources
- Mathematical derivation of emission factors for combustion processes
- Emission sources and releases of dioxin-like compounds to the environment
- Derivation of emission factors using stack testing data
- Numerical and statistical analyses

Appendix A lists the five reviewers ERG selected for the peer review meeting. While the reviewers' collective expertise is quite broad, they may have been unfamiliar with some material in the emission inventory report (e.g., a detailed understanding of every emission source of dioxins). As a result, the current peer review should be viewed as an extremely thorough, but not necessarily comprehensive, critique of the current dioxin emission inventory.

The reviewers were asked to complete a series of tasks before, during, and after the scheduled peer review meeting. Several weeks before the meeting, ERG distributed copies of the emission inventory report to the reviewers and asked them to prepare written comments based on their initial reviews of the document. ERG compiled these "premeeting comments," distributed them to the reviewers, and made several copies available to observers during the peer review meeting. These initial comments are included in this report, without modification, as Appendix B. It should be noted that the premeeting comments are preliminary in nature and reviewers provided

these comments to initiate and focus discussions during the meeting. As a result, the premeeting comments should not be considered as the reviewers' definitive opinions.

To focus discussions during the meeting, ERG worked with EPA to develop written guidelines for the technical review. These guidelines (commonly called a "charge") asked reviewers to focus their discussions on at least the following topics: whether EPA's general approach to compiling the dioxin emission inventory is reasonable, if the release estimates for each emissions source are accurate and based on representative data, and whether EPA should include additional sources in the emission inventory. A copy of the charge, which includes many topics in addition to those mentioned previously, is included in this report as Appendix C.

It should be noted that the reviewers were not asked to verify the accuracy of the entire database of source testing results. Recognizing the complexity of such a task, EPA has arranged for an independent audit of the database entries. Furthermore, due to time constraints, the reviewers were not required to consider in their discussions the many issues observers raised during the public comment sections of the meeting. To ensure that EPA considers the observer comments in some way, however, ERG submitted all written comments from observers directly to the authors of the emission inventory report.

Finally, to ensure that this summary report accurately reflects the reviewers' findings and recommendations, the reviewers were asked to prepare draft sections of this report during a writing session on June 5, 1998. A technical writer from ERG, who also attended the peer review meeting, compiled and edited these draft sections to prepare this final report. As the work plan for this peer review specifies, ERG's technical writer was responsible only for synthesizing this report from the information the peer reviewers provided, without embellishment, analysis, or interpretation.

1.3 Meeting Organization and Agenda

The peer review meeting, which was held at the Ramada Inn in Alexandria, Virginia, on June 3–4, 1998, was attended by the five expert reviewers and at least 52 observers. Appendix D lists the observers who confirmed their attendance at the meeting registration desk. The peer review meeting generally followed the agenda in Appendix E. As the agenda indicates, the meeting began with introductory comments by the designated chair of the peer review meeting. The subsequent discussion generally focused on one chapter of the dioxin emission inventory report at a time. During the technical discussions, the reviewers provided many comments and recommendations, as the charge requested. Several times throughout the meeting, the reviewers members requested comments from EPA representatives, but only to clarify specific topics. The agenda included two time slots for observer comments.

1.4 Summary of Opening Remarks at the Meeting

On the first day of the peer review meeting, Valerie Thomas (designated chair of the peer review) first welcomed the reviewers and the observers to the meeting. In the remainder of her opening remarks, the chair acknowledged the difficulties associated with compiling an emission inventory for dioxins and discussed the charge to the reviewers. David Cleverly (NCEA) and William Farland (NCEA) then provided an overview on EPA's development of the current dioxin emission inventory. More specifically, the representatives from EPA mentioned the need for a dioxins emission inventory and the differences between the 1994 and 1998 dioxins emission inventory reports.

1.5 Report Organization

The structure of this report reflects the order in which the reviewers evaluated the dioxin emission inventory document: The next section of this report summarizes the review of Chapter 1 of the inventory document, the section after that summarizes the review of Chapter 2, and so on. The "Executive Summary" at the beginning of this report presents a general overview of the reviewers' findings. Section 13 of this report lists all references cited in the text.

As mentioned earlier, the appendices to this report list the peer reviewers (Appendix A), the premeeting comments organized by author (Appendix B), the charge to the reviewers (Appendix C), the observers of the meeting (Appendix D), and the meeting agenda (Appendix E).

2.0 REVIEW OF CHAPTER 1, "INTRODUCTION"

The peer reviewers briefly discussed the introduction to the dioxin inventory report, which provided a historic perspective of EPA's development of the dioxin inventory, defined several classes of dioxin-like compounds, and described the toxic equivalency factors (TEFs) that are commonly used when evaluating mixtures of dioxin-like compounds. Based on their discussions, the reviewers made two recommendations for revising this chapter:

- *Provide more background information on TEFs*
  been established by "international convention." While the reviewers recommended that EPA continue to use these TEFs in the dioxin emission inventory, they suggested that the

  Health Organization (WHO), which include different toxicity factors for mammals, fish, and birds.

  Clarify definitions and abbreviations. Noting that EPA defines many terms and uses

  include a glossary, a list of all dioxin-like compounds (including their chemical compositions) that are included in the inventory, and a list of abbreviations.

3.0 REVIEW OF CHAPTER 2, "OVERVIEW OF SOURCES"

The peer reviewers focused a large part of their discussions on Chapter 2 of the emission inventory document, which provides an overview of the emissions estimation methodology and general findings of sources of dioxins in the United States. Overall, the reviewers found the inventory report (as summarized in Chapter 2) to be well written, comprehensive, and well documented. The inventory report clearly reflects a substantial amount of work, and the reviewers congratulated EPA on its efforts. The remainder of this section provides the reviewers' specific findings and recommendations for Chapter 2.

3.1 Overall Releases of Dioxins to the Environment

The peer reviewers concluded that most of the general findings summarized in Chapter 2 were well founded. However, they took exception to the major finding that the central estimate of releases of dioxin-like compounds to all environmental media (except products) was roughly 11,900 grams of toxic equivalents (TEQs) in 1987 and 3,000 grams of TEQs in 1995. After lengthy discussions, the reviewers concluded that this finding is incomplete, because the central estimates for 1987 and 1995 are the sum of releases for only those sources that could be quantified with at least a low confidence level. By virtue of this approach, the central estimates fail to account for a number of additional known dioxin sources for which EPA and other scientists have developed order-of-magnitude emissions estimates. Many of these excluded sources may have emissions that are as large as those EPA included in its central tendency estimate. For example:

- The order-of-magnitude estimates for dioxin emissions from landfill fires and backyard trash burning (see Chapter 6 of the inventory document) suggest that these sources may release more dioxins to the air than do most of the sources EPA included in the central estimate of releases to air.

- According to the emissions estimates in Chapter 8 of the inventory document, municipal wastewater treatment plants may release more dioxins to water than does any other source considered in the central estimate of releases to water.

Clearly, including these and other sources for which EPA offers rough estimates of dioxin emissions would significantly increase the central estimates of overall dioxin releases to the environment. Furthermore, the reviewers noted that the central estimate of overall dioxin releases excludes other potential sources of dioxin that have not been quantified with any degree of confidence (e.g., releases of dioxins from structural fires).

For these reasons, the reviewers recommended that EPA clarify the central estimate of dioxin releases to the environment. More specifically, they suggested that EPA revise Chapter 2 to clearly indicate that actual emissions of dioxins are likely significantly larger than the sum of emissions from just those sources characterized with some confidence. The reviewers suggested EPA make this revision using text like the following:

> The total emissions of dioxin to each medium, including emissions from those sources that are not completely characterized, is roughly "X" grams TEQ. Of this, "Y" grams TEQ can be characterized with reasonable confidence, while the remaining "Z" grams are based only on rough order-of-magnitude estimates.

In addition to finding the central estimate of overall releases to the environment incomplete, the reviewers made the following observation: A significant finding of the current inventory (compared to the 1994 assessment) is that very large quantities of dioxins can enter the environment in products. For example, EPA estimated that 25,000 grams TEQ of dioxin may be found in pentachlorophenol (PCP) used for wood treatment. This amount of dioxins is over eight times greater than EPA's central estimate of total releases of dioxins to air, land, and water in 1995. Although the fate of dioxins on treated wood and in other products is not fully understood, the reviewers noted that dioxins on treated wood appears to be the largest flow of dioxins that were quantified, thus making treated wood a large reservoir of dioxins in the environment. The reviewers understand that EPA will address reservoir sources in a separate volume of the Dioxin Reassessment, but they recommend that EPA put greater emphasis in the "General Findings" of Chapter 2 on the large amount of dioxins in products.

3.2 Uncertainty in the Emission Inventory

As the charge to the reviewers requested, the peer reviewers discussed in detail EPA's method of evaluating the uncertainty of, and assigning confidence ratings to, the various release estimates. As Chapter 2.1 of the inventory report describes, EPA assigned one of three levels of confidence (i.e., high, medium, or low) to the release estimate for every dioxin source category,[1] based on the information used to quantify emission factors and activity levels. Each level of confidence had a corresponding "range" (or uncertainty factor): Sources with "high" levels of confidence had a range of 2, sources with "medium" levels of confidence had a range of 5, and sources with "low" levels of confidence had a range of 10. As Chapter 2 of the inventory report describes, each range estimates how the actual releases to the environment for a source category might differ from EPA's estimated releases to the environment.

Following lengthy discussions on this topic, the peer reviewers found this confidence rating scheme and approach to assigning uncertainty ranges to be arbitrary and not necessarily a true reflection of the uncertainty in the emissions estimates. The reviewers also noted that the range estimates appear to have no scientific basis and cited examples in which the ranges may understate uncertainty. For instance, the peer reviewers thought that the uncertainty in the emissions estimate for many sources, especially those for which emission factors and activity levels are not well established, was higher than EPA portrayed in the emission inventory. Further, the reviewers indicated that some sources might have one facility with emissions high enough to dominate the national emission levels.

After discussing a number of alternative schemes for estimating and portraying uncertainties in the emissions inventory, the reviewers recommended the following improvements to the current approach:

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[1] In this discussion, an emissions "source category" refers not to a specific facility but rather to the general categories of sources EPA identified in Section 2 (e.g., municipal waste incinerators, cement kilns, and secondary copper smelters). The estimated emissions for a given "source category" represent the sum of emissions from all facilities that compose that source.

- *Add two levels of confidence*. The reviewers suggested that EPA add "rough order-of-magnitude" and "not quantified" as categories for levels of confidence. EPA then should assign every dioxin source—including those that are poorly characterized—one of the five total levels of confidence. Chapter 2 should clearly define the subjective criteria for classifying confidence levels.

- *Remove quantitative uncertainty ranges from all presentations*. Noting that the uncertainty ranges presented throughout the inventory report may not reflect the actual uncertainty in the emissions estimates, the reviewers recommended that EPA display only qualitative estimates of uncertainty (and not quantitative estimates) in all presentations of the emissions data. For example, the reviewers suggested that summary tables and figures list appropriate "level of confidence" categories instead of quantitative estimates of uncertainty.

- *Include quantitative indicators of uncertainty only in the text of Chapter 2*. Although the reviewers recommended that the presentations of emissions data only indicate qualitative estimates of uncertainty, the reviewers agreed that the definitions of the "level of confidence" categories in Chapter 2 should include some quantitative estimate of uncertainty. The reviewers thought these quantitative estimates should have broader and more flexible ranges than those presented in the draft inventory report.

The peer reviewers felt the preceding recommendations were warranted for several reasons. First, including "rough order-of-magnitude" calculations for poorly characterized sources indicates the relative importance of every quantified source. The reviewers felt it was critical to attempt to define the potential emissions of all sources, including several that currently have no estimates (e.g., accidental structure fires). Given the apparent relative importance of some of these sources, like those in Table 2-5 of the inventory document, the reviewers also thought that further analysis of the potential upper limit should accompany the rough order-of-magnitude analysis. By including the emissions estimates (and their corresponding confidence levels) from all sources together, EPA can ensure that Chapter 2 of the inventory document better highlights the importance of poorly characterized sources of dioxins.

3.3 Presentation of Information

After discussing the contents of several displays in Chapter 2 of the inventory document, the peer reviewers were concerned that the displays, when portraying general findings, exclude

some source categories. The reviewers made the following recommendations for revising displays in Chapter 2 to include all source categories:

- *Restructure Tables 2-2 and 2-3 and Figures 2-1, 2-2, and 2-3 to include emissions estimates for all sources*. The reviewers suggested that EPA revise the listed tables of the inventory document as separate tables for releases of dioxins to air, water, land, and products and that EPA list every known and potential source of dioxins in the tables (regardless of whether the emissions were even quantified). The entries for each source should list the central release estimates for 1987 and 1995 (if a release was estimated), confidence ratings for the release estimate, and selected comments relative to future trends. By this approach, source categories that have only an order-of-magnitude estimate will be included in the summaries, but with notes indicating appropriate levels of confidence.

- *Note source categories that are only partially characterized in the inventory*. When reviewing the inventory report, the reviewers found that the activity levels for some source categories may have failed to account for all potential sources of dioxin associated with a process. For example, primary smelters, secondary smelters, and some other industrial sectors currently refine scrap copper, but the activity levels for primary copper smelters did not account for the large quantities of scrap copper processed by these other facilities. The reviewers made similar observations for the activity levels for secondary aluminum smelters and other source categories. To ensure that the summary tables accurately reflect the current status of the inventory, the reviewers recommended that these tables note specific source categories that are only partially characterized.

3.4 Time Frames for Emissions Estimates

The peer reviewers concluded that establishing clear time frames for annual emission estimates (i.e., baseline years 1987 and 1995) significantly improves data presentation.[2] In some cases, the time frames could be further extended to include expected trends. Because future trends in dioxin emissions are important to policy makers who may prepare regulatory actions for the highest priority sources, the reviewers recommended that Chapter 2 of the inventory report project some future levels of dioxin emissions. More specifically, the peer reviewers suggested that EPA include in Chapter 2 projected dioxin emissions—possibly for the year 2000—for

[2] The reviewers agreed that reported reductions of dioxin releases between 1987 and 1995 were reasonable for some source categories (e.g., municipal waste incinerators, medical waste incinerators, and wood treated products). However, the reviewers did not evaluate the changes in releases for every source category.

sources (1) that already have new environmental regulations promulgated (e.g., municipal solid waste and medical waste incinerators) and (2) for which EPA has prepared regulatory impact analyses. When including projections, the reviewers said that the report should make it clear that estimates from regulatory impact analyses are based on the assumption of full compliance with environmental regulations.

3.5 Comparison with International Emissions Inventories

One "General Finding" of the inventory report is that results of the U.S. dioxins inventory are consistent with the results of national inventories published by several European countries.[3] The peer reviewers offered several reasons that such statements should be made with caution. For example, detailed comparisons of one country's inventory to that of another should consider relevant differences of those countries, such as industrial structures, waste management practices,[4] and required pollution controls. Further, because the knowledge of dioxin sources has evolved greatly over the past 10 years, it may not be meaningful to compare old inventories to newer ones. Finally, the comparisons in the inventory document do not include potential dioxin sources that are not well characterized. As an alternative, the reviewers recommended that EPA compare its methodologies, approaches, lists of identified sources, and specific emission factors to those cited in inventories prepared by other countries. Such comparisons would be more appropriate than comparisons of central estimates of annual releases.

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[3] One reviewer noted that the latest inventory studies from the United Kingdom were not used by EPA in the comparison to other national inventories. These inventory studies are documented in the following references: EPA, 1997a; HMIP, 1995; Dyke et al., 1997; Eduljee and Dyke, 1996. These inventory studies represent the most up to date picture of releases in the United Kingdom, although releases are thought to have fallen recently with the implementation of new emission standards.

[4] As an example of how issues pertaining to waste management affect the comparisons with inventories compiled by other countries, inventories compiled in the United Kingdom (HMIP, 1995) generally consider transfers to landfills as releases to the environment, but the inventory compiled by the United States does not.

3.6 The Criteria Used to Include/Exclude Emissions Data

After lengthy discussions on the topic, the peer reviewers questioned several aspects of EPA's criteria for including and excluding emissions data from the dioxin inventory. First, reviewers noted that the Chapter 2 text (e.g., see page 2-5 of the inventory report) does not clearly indicate whether EPA considered all sources of data, particularly regulatory compliance data and data collected in foreign countries. Second, reviewers took exception with EPA's decision to consider only emissions data published in peer-reviewed literature. The reviewers members indicated that this practice (1) likely caused EPA to overlook some high quality emissions data and (2) offered no guarantee that EPA considered emissions data that represent entire source categories.

Indicating that EPA should balance its concern for considering high quality, representative data with the need to characterize as many sources as possible, the peer reviewers made the following recommendations for EPA's criteria for including emissions data in the inventory:

- *Evaluate as many data sources as possible*. To develop the most comprehensive emissions inventory possible, the reviewers recommended that, where feasible, EPA evaluate all available data for reliability, quality, comparability, and representativeness to the source categories in the United States.

- *Treat foreign data and domestic data on a more equal basis*. The reviewers felt that EPA could make better use of data from foreign countries to estimate emissions, especially where domestic data are incomplete. In cases where foreign data prove comparable to U.S. sources, EPA can use these data for comparison purposes or to estimate the emission factors for the source category. In cases where there is no information on the comparability of foreign data, EPA can still use the foreign results but should clearly note the data limitations and assign an appropriate "level of confidence" category and note that domestic data is required to improve the estimates.

3.7 Omission of Selected Dioxin-Like Compounds

The peer reviewers noted that, although the inventory supposedly includes all "dioxin-like" compounds, Chapter 2 of the document deals almost exclusively with chlorinated dioxins and furans. To ensure that Chapter 2 provides a comprehensive summary of the inventory, the

reviewers recommended that EPA revise parts of the chapter to indicate that there is significantly more knowledge of sources of the chlorinated dioxins and furans than there is of dioxin-like polychlorinated biphenyls (PCBs) and selected brominated compounds.

4.0 REVIEW OF CHAPTER 3, "COMBUSTION SOURCES OF CDD/CDF: WASTE INCINERATION"

This section presents the peer reviewer's comments and recommendations on the estimated releases of dioxins from waste incineration operations. Chapter 3 of the inventory document considers eight different categories of waste incineration sources.

4.1 Municipal Solid Waste Incineration

The peer reviewers carefully reviewed the emissions of dioxins reported for municipal solid waste incinerators (MSWIs). As Figure 2-1 of the inventory document shows, MSWIs reportedly release more dioxins to the air than does any other single source quantified by EPA. In general, some reviewers thought that certain emission factors for this source category may have been unrealistically low, while some observers indicated that certain emission factors may have been too high (and based on old data). In the short time provided to review this source, the reviewers could not conclude whether the overall emissions estimates for MSWIs were reasonably accurate, but the reviewers agreed that the emissions from MSWIs likely decreased from 1987 to 1995, as the inventory report suggests. Nonetheless, given the magnitude of emissions estimated for MSWIs, the reviewers noted that understated or overstated emission factors for this source could significantly affect the overall dioxin inventory. The reviewers suggested that EPA consider the following recommendations:

- *Ensure that the selected subcategories are meaningful.* After discussing EPA's approach to subcategorizing MSWIs, the reviewers questioned whether EPA selected subcategories that reflect the latest appreciation of the mechanisms of dioxin formation and controls. The reviewers said there may be a case for reducing the number of subcategories based on the theoretical understanding of dioxin formation or the fact that some control technologies do not significantly affect releases of dioxin.

- *Review descriptions of industrial processes for technical accuracy.* The reviewers noted that several descriptions of MSWI processes were incomplete or inaccurate. Specific examples included the following: One reviewer noted that "starved" modular incinerators are not "newer" technologies and generally are not "easier and less expensive to operate," as the inventory report suggests; the reviewer also indicated that particulate matter emissions from modular incinerators are relatively low due to the low flow velocities in the

primary chamber and not to "high and uniform temperatures in the secondary" chamber, as the EPA report suggests; and the reviewer also suggested that EPA could clarify its definitions of refuse-derived fuel (RDF) facilities and co-firing. An observer indicated that small-scale MSWIs (e.g., an Alaskan facility) may fit a "new" source subcategory that EPA did not consider. Given these and possibly other unclear or incorrect technical descriptions, the reviewers suggested that EPA perform a thorough technical review of Chapter 3.1.1 of the inventory report.

- *Consider revising the section on dioxins in landfill ash*. The peer reviewers thought the discussions of dioxins in MSWI ash in Chapter 3.1.6 may mislead some readers, particularly because even though MSWI ash must be disposed of in permitted landfills, EPA notes that the dioxin inventory does not account for landfill releases. In any case, the reviewers agreed that significant quantities of dioxins may be found in MSWI ash, especially where pollution controls are used to reduce air releases. Should EPA decide to keep the discussion of dioxin in MSWI ash in the final report, the reviewers recommended including text acknowledging that the amounts of dioxin in MSWI ash are expected to vary significantly with differing combustion systems and air pollution controls. One reviewer indicated that the total formation of dioxin is considerably lower for modern combustor systems than it is for older systems.

- *Verify the accuracy of database entries*. The peer reviewers noted that public comments from a trade association suggested that EPA's dioxin inventory database has inaccurate information on MSWIs: some test results do not appear in the database, some test results are incorrect, and some MSWIs are subcategorized incorrectly. The reviewers recommended that EPA investigate these comments before releasing the inventory. (Note: As Section 1.2 of this report describes, the reviewers were not asked to verify the accuracy of the emissions database.)

- *Incorporate additional emissions testing data*. The peer reviewers recommended that, where domestic source testing data are lacking, EPA consider using dioxin emissions testing data from the literature or from studies conducted overseas to estimate emission factors for MSWI subcategories. EPA might also use data from the literature and from foreign countries to verify emission factors for subcategories with limited domestic emissions data. (The reviewers did not provide specific references for other data sources.)

- *Explain why emission factors for 1987 and 1995 are identical*. In the current inventory, EPA assumes that the emission factors for a given MSWI subcategory are identical for baseline years 1987 and 1995. Citing examples of how dioxin emissions from MSWIs decreased over this time frame due to improved design and operational practices, the peer reviewers wondered if EPA's assumption accurately reflects levels of dioxin emissions in the two baseline years. The reviewers thought EPA should reconsider the validity of this assumption and revise the text to acknowledge its limitations.

- *Include the estimate of future emissions in the summary sections*. The peer reviewers agreed that the estimate of future annual releases from MSWIs of 24 grams TEQ is reasonable given the recent promulgation of strict emission standards for this source. Accordingly, the reviewers noted that, for sake of completeness and for the benefit of policy makers, EPA should include the estimate of future releases of dioxins for MSWIs in the "General Findings" section of the inventory (see Section 3.4).

4.2 Hazardous Waste Incineration

Some of the peer reviewers found EPA's estimated emission rates from hazardous waste incinerators (including industrial boilers that burn hazardous wastes) to be reasonable, but one reviewer suggested that EPA may have significantly underestimated emissions from this source category. The reviewers recommended that EPA incorporate in Chapter 3.2 several technical and editorial revisions:

- *Acknowledge the existence of other data.* The peer reviewers noted that, by 1996, as many as 24 facilities within this source category may have been tested, but the document only refers to 17 facilities that were tested. The reviewers recognized that EPA may have had too little time to include the most recent testing results, but they strongly recommended that the final report should consider these additional data.

- *Review descriptions of industrial processes for technical accuracy.* The peer reviewers found several potential inaccuracies in EPA's descriptions of the industrial processes in this source category. For instance, one reviewer noted that the report implies that current regulations limit industrial boilers to burning no more than 5 percent (by weight) of liquid hazardous waste, which is incorrect. Given these and other potential errors in the text, EPA should carefully review and revise, as appropriate, the technical descriptions of sources in this category.

- *Include a more extensive comparison of emission estimates derived in this document and emission estimates derived by EPA's Office of Solid Waste (OSW).* The report indicates that OSW has used a different assessment methodology to estimate dioxin emissions from hazardous waste incinerators, yet it does not compare estimates of total emissions using the OSW approach to estimates of total emissions using the emission factor approach. The reviewers thought that such a comparison, including explanations of any discrepancies between the findings of the separate studies, would have been worthwhile.

- *Explain why emission factors for these sources for 1987 and 1995 are identical.* Noting that EPA used the same emission factor (but two different activity factors) to estimate emissions from hazardous waste incinerators in 1987 and 1995, the reviewers wondered if

changes in operating procedures or in incineration and air pollution control technologies might have warranted the use of two different emission factors. If not, the reviewers said the report should state why using one emission factor for 1987 and 1995 is justified.

- *Ensure that source categories are defined clearly*. Several reviewers indicated that flawed definitions of this source category may lead to both overstated and understated emissions in the overall inventory. For example, one reviewer noted that this section does not address light weight aggregate kilns, which may have relatively high emissions. Another reviewer noted that some emissions cited in this section may overlap with emissions presented in Chapter 5.1.2, "Cement Kilns Burning Hazardous Waste." The reviewers recommended that EPA carefully re-examine this source categorization, since it may affect the findings of the overall emission inventory.

- *Revise discussion on uncertainty.* Presently, the EPA report assigns a "medium" uncertainty factor to emissions estimated for dedicated hazardous waste incinerators and a "low" factor to emissions estimated for industrial boilers. By the report's current definition of these uncertainty factors, these source subcategories would have uncertainty ranges of a factor of 5 and 10, respectively. As Section 3.2 of this report describes, the reviewers recommended that EPA present only qualitative, and not quantitative, estimate of uncertainty with the dioxin emissions.

- *Make editorial revisions*. In several instances, Chapter 3.2 of the report refers to MWIs (medical waste incinerators) where it should apparently refer to HWIs (hazardous waste incinerators). Further, Equation 3-4 appears to be incorrect and should include a factor of 17 in the denominator on the right-hand side of the equation; and one reviewer recommended that EPA avoid the "double use" of summation signs in this equation, and other equations in the report. Also, some text in Chapter 3.2.3 indicates that 17 hazardous waste incinerators were tested, but other text in the section indicates 18 were tested. These errors and inconsistencies should be corrected.

4.3 Medical Waste Incineration

In discussing EPA's estimates of dioxin releases from MWIs, the peer reviewers agreed that EPA clearly described its assumptions and effectively compared its emissions estimation approach to approaches recently taken by other agencies. The reviewers also agreed that the reported reduction in emissions from 1987 to 1995 for this source category is reasonable. The reviewers suggested that EPA consider the following recommendations:

- *Ensure that the emissions testing data represent the source.* EPA should consider additional data (perhaps from overseas) to improve the limited data set if possible. One

reviewer noted that it can be difficult to get emissions testing data that is representative of emissions from small batch operated plants because steady-state operations may emit lower levels of dioxins than intermittent operations.

- *Revise discussion on uncertainty*. Noting that EPA assigned "low" confidence ratings to both the emission factor and the activity level for MWIs, the peer reviewers agreed that an uncertainty factor of 10 is not supported for this source, especially because less than 1 percent of the existing facilities were tested. Section 3.2 of this report describes the peer reviewers' general recommendations on how EPA should present uncertainty in the inventory.

- *Predict levels of emissions*. Consistent with the recommendations in Section 3.4 of this report, one reviewer suggested that EPA include in its report an estimate of how recently promulgated emission standards might affect future levels of dioxin emissions from MWIs.

- *Make editorial revisions*. One reviewer noted that Table 3-16 in the inventory report does not show footnotes "f" through "n," and another reviewer indicated that these footnotes may not have been necessary to include in the table in the first place. One reviewer suggested that EPA remove the "double use" of summation signs in Equation 3-7 and indicated that the nomenclature used in the equations should be consistent throughout the report.

4.4 Crematoria

Even though emissions of dioxin from crematoria account for a very small fraction of the overall releases of dioxin in the inventory, the peer reviewers felt that two recommendations were warranted:

- *Consider emissions data collected in Europe*. The peer reviewers disagreed with the inventory report, which states that the 0.5 µg TEQ per body of emissions measured at a crematorium in the United States is "very similar to" the 4.9 µg TEQ per body of emissions measured at two Dutch crematoria. Because test results in Europe are in fact higher and quite different from the single set of U.S. tests, the reviewers suggested that EPA consider revising the emission factor using the European data.

- *Consider emissions data collected in the United Kingdom*. One reviewer noted that additional test data are available on two crematoria in the United Kingdom (WSL, 1993). The emissions tests were conducted both on an older system and a newer system. The older system had chambers preheated to 650^{o} C, a measured residence time of 1 second, and an air injector exhaust; and the newer system had a 2 second residence time in a chamber heated to 850^{o} C. The emissions testing results, combined with the gas generation rate reported by the Dutch study, indicated emission factors of 70–80 µg TEQ

per body (HMIP, 1995), an emission factor over two orders of magnitude greater than the emissions data measured in the United States. For sake of completeness, the reviewers recommended that EPA consider the emissions data collected in the United Kingdom when revising the emission factor for crematoria.

4.5 Sewage Sludge Incineration

Regarding EPA's estimate of dioxin releases from sewage sludge incinerators, the peer reviewers had two recommendations:

- *Create subcategories, if appropriate*. EPA's report describes three technologies used to incinerate sewage sludge in the United States. The reviewers suggested that EPA examine the emissions data to determine if emission factors differ significantly among the three sewage sludge incinerator technologies. If so, EPA should revise its emissions estimate accordingly. (Note: One reviewer indicated that studies performed in the United Kingdom suggest that emissions from multiple-hearth incinerators with simple emissions controls are much higher than emissions from fluidized-bed incinerators with modern pollution controls.)

- *Revise discussion on uncertainty*. The peer reviewers judged that the uncertainty in the reported emissions estimate is greater than a factor of five. Section 3.2 of this report describes the peer reviewers' general recommendations on how EPA should present uncertainty in the inventory.

4.6 Tire Combustion

After brief discussions on dioxin emissions from tire combustion, the peer reviewers offered only one recommendation for this source:

- *Revise discussion on uncertainty*. Because EPA based its emission factor on testing performed at one, well-controlled tire incinerator, the reviewers believed the emission factor may not necessarily represent emissions from other facilities that incinerate tires. As a result, the peer reviewers concluded that the uncertainty in emissions from tire combustion is greater than a factor of 10. Section 3.2 of this report describes the peer reviewers' general recommendations on how EPA should present uncertainty in the inventory.

4.7 Combustion of Wastewater Sludge at Bleached Chemical Pulp Mills

The peer reviewers had no comments or recommendations for this source.

4.8 Biogas Combustion

The peer reviewers offered only one recommendation for this source:

- *Ensure that the emissions testing data represent the source.* The reviewers suggested that EPA ensure that the emissions measurements considered in this section are interpreted in context. Of particular concern, the concentrations that were measured during the emissions test might have represented levels of dioxin within the flare rather than in the emissions from the flare. EPA should verify whether this is the case.

5.0 REVIEW OF CHAPTER 4, "COMBUSTION SOURCES OF CDD/CDF: POWER/ENERGY GENERATION"

The following subsections summarize the reviewers' thorough discussions of dioxin sources that relate to power and energy generation processes. Chapter 4 of the inventory document considered four different categories within this group of processes, which are covered separately below.

5.1 Motor Vehicle Fuel Combustion

The peer reviewers generally found the subcategories EPA selected for this source to be appropriate, and they approved EPA's use of data collected in Europe when the data collected in the United States were incomplete or nonexistent. The reviewers also agreed that EPA correctly classified the confidence level for this source as "low," due to the inherent variability in vehicle fuel composition and motor vehicle emissions. The reviewers suggested that EPA consider the following recommendations for this source category:

- *Emphasize the uncertainty associated with the emission factors*. There are few tests on emissions from diesel and unleaded gasoline fueled vehicles, and the range of operational, technical, and environmental conditions is so large that it is very difficult to derive an emissions estimate from the limited data. There is some suggestion that levels of chlorine in air may affect emissions and some indication that urban driving may have different emissions from highway use. As a result, the peer reviewers noted that the emission factor for motor vehicles may be quite uncertain, because the factor for vehicles that use diesel fuel is derived from just one emissions test (i.e., the study of the Fort McHenry Tunnel in Baltimore) and the factor for vehicles that use unleaded gasoline is extrapolated from limited studies in Europe.

- *Consider adding subcategories to this source*. The reviewers recommended that EPA make rough order-of-magnitude estimates of emissions from nonroad vehicle use (e.g., farming equipment) and use of diesel vehicles other than heavy-duty trucks (e.g., buses), or at least quantify the activity levels—such as total fuel consumed—for these subcategories. The reviewers felt that a separate estimation of emissions from agricultural machinery would be appropriate to EPA's exposure reassessment efforts, especially because these nonroad vehicles operate close to agricultural produce.

- *Revise discussion on uncertainty*. The reviewers concluded that the uncertainty in emissions from motor vehicles is probably greater than a factor of 10, because the

emissions estimate is based on testing data that likely do not represent the extremely diverse fleet of U.S. motor vehicles and the variable compositions of vehicle fuels. Refer to Section 3.2 of this report for the peer reviewers' general recommendations on how EPA should present uncertainty in the inventory.

EPA should note that one reviewers suggested that the emission factor for motor vehicle combustion of leaded fuels in 1987 should be revised using the tailpipe emissions results Bingham reported (Bingham et al., 1989). Further, another reviewer recommended that EPA ensure that the unleaded vehicle emission factor, which was derived from three cars tested in Europe, adequately represents the diverse fleet of motor vehicles in the U.S.

5.2 Wood Combustion

The reviewers thoroughly discussed EPA's estimates of dioxin releases from residential and industrial wood combustion processes. The reviewers' findings and recommendations for these source categories follow.

5.2.1 Residential Wood Combustion

Regarding EPA's estimate of dioxin releases from residential wood combustion, the peer reviewers had three recommendations:

- *Revise discussion on uncertainty.* With no testing data that characterize residential wood combustion sources in the United States, the reviewers recommended that EPA adopt a broader uncertainty factor for this source. Section 3.2 of this report describes the peer reviewers' general recommendations on how EPA should present uncertainty in the inventory.

- *Consider additional data sources.* In the inventory report, EPA estimates that there are 25,000,000 residential wood combustion sources in the United States, yet none have been tested for dioxin emissions. To portray releases from this source accurately, the reviewers agreed that EPA should consider several data sources in addition to the two "direct measurement studies" cited in the inventory report. More specifically, one reviewer suggested that EPA consider data on emissions from wood stoves and fireplaces from a Dutch inventory study (Bremmer et al., 1994). The Dutch study reportedly found emission factors between 1.0 and 3.3 ng TEQ per kilogram of wood combusted in wood stoves and emissions factors between 13.0 and 28.5 ng TEQ per kilogram of wood

combusted in fireplaces. These emission factors are notably higher than the emission factor that EPA used in its inventory (i.e., 2.0 ng TEQ per kilogram of wood combusted). The reviewer also noted that tests in Germany have measured concentrations of dioxins in the emissions from various residential wood combustion sources, including stoves and fireplaces (Umweltbundesamt, 1996). One reviewer suggested that emissions tests have also been conducted in Canada, but a reference for these tests was not provided. The peer reviewers recommended that EPA consider these test results in the current inventory.

- *Acknowledge factors that may contribute to higher emissions.* When residents burn waste materials or treated wood, emissions from residential combustion sources may be considerably higher than EPA's estimates. Further, combustion of wood that was soaked in salt water has also been noted to increase emissions from this source. EPA should account for these possibilities in some way.

5.2.2 Industrial Wood Combustion

Regarding EPA's estimate of dioxin releases from industrial wood combustion, the peer reviewers had three recommendations:

- *Verify that emission factors represent the entire spectrum of sources.* The peer reviewers noted that "industrial wood combustion" encompasses a wide range of industrial processes, including large-scale, dedicated boilers and small, hand-stoked units commonly found in joiners and furniture factories. However, EPA used emissions testing data that apparently do not represent emissions from small-scale facilities and facilities that combust treated wood waste. The peer reviewers recommended that EPA use information from a wider range of sources in this category and suggested that it may find such information in the inventories compiled by Germany, The Netherlands, and the United Kingdom.

- *Acknowledge factors that may contribute to higher emissions.* The peer reviewers recommended that EPA consider including a separate subcategory in the emission inventory for industrial sources that combust wood that has been soaking in sea water. These sources have been shown to have significantly higher emissions than other industrial wood combustion sources, due to the availability of inorganic chlorides from the salt water. In fact, the inventory report indicates that EPA estimated an emission factor of 17.1 ng TEQ per kilogram of water-soaked wood burned, which is significantly higher than the emission factor EPA applies to all industrial wood combustion sources (i.e., 0.82 ng TEQ per kilogram of wood burned). The reviewers suggested that EPA subcategorize these sources in the inventory to reflect the higher emissions thought to occur from combustion of sea water-soaked wood.

5.3 Oil Combustion

The peer reviewers found EPA's discussion of emissions from oil combustion to be less detailed than discussions on emissions from other sources. The reviewers made no comments specific to residential and commercial combustion of oils, but they offered the following recommendations for utility sector and industrial oil combustion section (i.e., Chapter 4.3.2 in the inventory document):

- *Compare more extensively the two sets of emissions data for domestic sources.* The emission inventory report describes emissions data collected by EPA's Office of Air Quality Planning and Standards (OAQPS) and the Electric Power Research Institute (EPRI). The reviewers recommended that EPA compare these testing efforts in greater detail, possibly by describing the specific furnaces types, air pollution control devices, and fuel oils that were tested. One reviewer asked that EPA also indicate the ranges of sulfur content in the tested fuels, because the sulfur content in fuel oils could affect the amount of dioxin emissions.

- *Verify that emission factors represent the entire spectrum of sources.* Some reviewers were concerned that the emission factors may not accurately reflect the entire range of industrial oil combustion sources. For example, the inventory apparently fails to consider sources that combust used or recovered oils. Further, two reviewers suggested that the oil combustion emission factor must be carefully developed due to some sources having extremely high flue gas flow rates—these sources might also have relatively high dioxin emissions. Finally, one reviewer indicated that EPA may wish to include emission factors from the Dutch inventory if sources operating in marine environments—where chloride and other contaminants may be present. EPA should account for the diversity of these sources in the final inventory document.

5.4 Coal Combustion

Except for noting that EPA might consider emissions data from Germany, the peer reviewers made no specific recommendations for revising the releases estimated from residential and commercial coal combustion units. For utilities and industrial boilers, however, the peer reviewers made the following recommendations:

- *Revise discussion on uncertainty.* Given the large size of individual units in this source category, a few sources with high emissions could significantly change the emissions estimates. One reviewer noted that emissions from a small subset of untested units,

particularly those with very large flue gas flow rates, might be significantly higher than the emissions EPA estimated for the entire industry.

- *Verify that emission factors represent the entire spectrum of sources.* The reviewers thought EPA clearly presented relevant emissions data collected by EPRI and the Department of Energy (DOE). Because the EPRI and DOE data only characterized emissions from units with cold-side electrostatic precipitators (ESPs), the reviewers suggested that EPA determine whether these data accurately represent the national inventory of coal-fired units. To portray emissions from this industry accurately, the reviewers recommended that EPA determine if any available data quantify the different types of boilers, the distribution of different fuel types, the number of units with different air pollution control equipment, and the number of units with high potential for dioxin formation.

- *Consider additional data sources.* One reviewer indicated that EPA apparently did not consider testing data from the United Kingdom for several large coal-fired boilers in power plants and industrial applications (CRE, 1994; IEA, 1993). These testing data indicate emission factors of 0.4–4.8 ng TEQ per kilogram of coal combusted in industrial boilers and 0.06–0.32 ng TEQ per kilogram of coal combusted in power generation plants. Both sets of emission factors are significantly higher than EPA's proposed emission factor (i.e., 0.087 ng TEQ per kilogram of coal combusted). The reviewers noted that it is unclear whether the data collected in the United Kingdom accurately represent U.S. sources, but they suggested EPA acknowledge that emission factors higher than those in the inventory report have been found.

6.0 REVIEW OF CHAPTER 5, "COMBUSTION SOURCES OF CDD/CDF: OTHER HIGH TEMPERATURE SOURCES"

The following discussion summarizes the reviewers' findings on eight categories of high temperature dioxin sources that EPA did not classify in Chapters 3 and 4 of the inventory report. Of these source categories, only cement kilns rank among the 15 with the highest levels of dioxin emissions to the air (see Figure 2-1 of the inventory report). As a result, the reviewers discussed at length EPA's emissions estimates for cement kilns and spent less time discussing the emissions estimates for the other seven source categories.

6.1 Cement Kilns

The peer reviewers offered several important recommendations to ensure that EPA portrays these sources accurately in the emission inventory:

- *Include light weight aggregate kilns in the inventory.* Two reviewers indicated that EPA's emission inventory currently fails to address emissions from light weight aggregate kilns and agreed that EPA should include this source in the inventory (possibly in, or after, the cement kilns chapter). One reviewer added that OSW recently estimated that light weight aggregate kilns that burn hazardous waste release 3.1 grams TEQ per year. If EPA agrees that the OSW estimate portrays this source category accurately, emissions from light weight aggregate kilns would rank among the top 20 sources of dioxin emissions to the air.

- *Compare current emissions estimates with OSW's emissions estimates.* One reviewer wondered why the inventory report considered emissions testing results from 12 cement kilns but overlooked OSW's recent testing effort of as many as 30 cement kilns. The OSW emissions estimate for cement kilns (i.e., 57 grams TEQ per year) is roughly three times lower than that in the inventory report (i.e., 153 grams TEQ per year). While the peer reviewers did not necessarily suggest that EPA incorporate OSW's emissions estimates into the inventory, they agreed that the current report should at least cite the OSW data and account for differences between the two differing estimates. EPA may also wish to include emissions data from the scientific literature.

- *Confirm the need to select subcategories.* After reviewing the available data, the peer reviewers questioned whether EPA was justified in dividing cement kilns into (1) those that burn hazardous waste and (2) those that do not. More specifically, the reviewers noted that the OSW study and selected European studies suggest that dioxin emissions from cement kilns that burn hazardous waste do not differ significantly from emissions

from kilns that burn conventional fuels. Some peer reviewers observed that the operating temperature of a cement kiln's ESP appears to affect the magnitude of dioxin emissions much more than does the feed composition. If this is the case, the reviewers thought that subcategories based on kiln operating parameters would be more appropriate than subcategories based on the nature of the feed. The reviewers recommended that EPA carefully review its approach to assigning subcategories for this source, especially because emissions from cement kilns account for such a large fraction of overall dioxin emissions in the inventory.

- *Review descriptions of industrial processes for technical accuracy.* Two reviewers noted that the inventory report does not accurately describe how wastes are introduced into cement kilns. They further noted that the report should mention other waste introduction techniques, like midpoint injection. The peer reviewers suggested that EPA revise the text accordingly.

- *Make editorial revisions.* On page 5-3 of the inventory report, EPA indicates that "most of the cost" of operating cement kilns is associated with fossil fuel consumption, but a peer reviewer suggested that possibly only 30 percent of the operating costs relate to burning fossil fuels. While reviewers found the passage on cement kiln dusts interesting, one reviewer found the text to be unclear and recommended that EPA revise Chapter 5.1.6 to (1) indicate whether the testing data represent all cement kilns or only those that burn hazardous waste and (2) clarify the impacts of nondetect observations on the estimated emission factor. The peer reviewers suggested that EPA research and address these comments.

6.2 Asphalt Mixing Plants

EPA did not quantify an emissions estimate for asphalt mixing plants but rather included an order-of-magnitude estimate of the emissions (see Table 2-5 of the inventory report) based on emission factors derived from a single set of European source testing data. The peer reviewers found EPA's analyses to be reasonable in the absence of better data. During the public comment period, one observer indicated that there are currently several thousand asphalt mixing plants in the United States and that elevated emissions from a small subset of these plants may lead to much higher emissions than those EPA estimated. (As Section 1.2 of this report notes, the reviewers were not required to address the issues observers raised during the public comment period.)

6.3 Petroleum Refining Catalyst Regeneration

The peer reviewers understood that EPA may consider results from ongoing source testing efforts to characterize dioxin emissions from catalyst regeneration processes and offered two recommendations for this source:

- *Consider additional data sources.* One reviewer indicated that the California Air Resources Board (CARB) has recently studied emissions from this source and suggested that EPA consider the CARB data, if available. The reviewers did not know of an appropriate reference for the CARB study.

- *Revise passages in the text.* Although Chapter 2 of the inventory report indicates that EPA did not estimate emissions for this source due to insufficient testing data, the text in Chapter 5.3 does not clearly state this conclusion. The reviewers suggested that EPA add an appropriate summary sentence to Chapter 5.3. Further, one reviewer thought some sampling results for untreated wastewater (e.g., 57.2 ng TEQ per liter of wastewater) seemed high and recommended that EPA carefully consider the fate of this waste stream (and similar streams).

6.4 Cigarette Smoking

The peer reviewers had no recommendations for this source but commented that cigarette smoking may be an important issue to consider in the exposure assessment, given the proximity of the emissions sources to human receptors.

6.5 Pyrolysis of Brominated Flame Retardants

The peer reviewers noted that Chapter 5.5 of EPA's report evaluates potential releases of polybrominated dibenzo-p-dioxins (PBDDs or BDDs) and polybrominated dibenzofurans (PBDFs or BDFs) to the environment. The peer reviewers thought EPA should clearly indicate in the "General Findings" how the inventory accounts for emissions of this group of compounds. (See Section 3.7 of this report for more details.)

6.6 Carbon Reactivation Furnaces

The peer reviewers had no recommendations for this source, but one reviewer thought EPA should possibly assign the estimated emissions a different confidence level (see Section 3.2

of this report) due to the absence of reliable activity level data (e.g., the mass of granulated activity carbon that facilities reactivate each year).

6.7 Kraft Black Liquor Recovery Boilers

After brief discussions on this source category, the peer reviewers offered only one recommendation for this source:

- *Verify that emission factors represent the entire spectrum of sources.* One reviewer recommended that EPA explicitly evaluate whether the available emissions data represent the broad range of sources in this category. Another reviewer suggested that EPA can make such an assessment by tabulating the number of black liquor recovery boilers that use different combinations of air pollution control devices (provided these data are available).

6.8 Other Identified Sources

The peer reviewers generally agreed that the emissions sources listed in Chapter 5.8 of the inventory most likely exist in the United States but probably do not emit significant quantities of dioxin to the environment. The reviewers suggested that EPA continue to assess these sources, especially (1) as more emissions data become available and (2) if significant changes in a given industry may affect dioxin emissions (e.g., dioxin emissions from glass manufacturing processes could potentially increase if increases in recycling lead to the introduction of contaminants that could contribute to dioxin formation).

7.0 REVIEW OF CHAPTER 6, "COMBUSTION SOURCES OF CDD/CDF: MINIMALLY CONTROLLED AND UNCONTROLLED COMBUSTION SOURCES"

This section presents the peer reviewers' findings on seven categories of minimally controlled and uncontrolled combustion sources of dioxins. According to Table 2-2 of the inventory document, EPA quantified emissions from only one of these source categories: forest and brush fires. Because several of the source categories might be major sources of dioxin emissions, the reviewers took exception with how EPA excluded from selected summary statistics estimates of potential emissions for many of these sources. Sections 3.1 through 3.3 of this report offered several recommendations for how EPA can more accurately portray emissions sources that may be difficult to quantify. The following discussion summarizes the reviewers' recommendations for revising Chapter 6 of the inventory document.

7.1 Combustion of Landfill Gas

The peer reviewers offered only one recommendation for this source:

- *Include an emissions estimate in the inventory.* The peer reviewers concluded that EPA should include an estimate of dioxin emissions from this source in the final inventory, despite a lack of extensive testing data. One reviewer commented that the inventory report cites just as much emissions data for combustion of landfill gas (which was not quantified in the inventory) as for sources EPA quantified in the inventory. EPA should note that an observer indicated that additional testing data are available for this source, but a reference for these data was not provided. One reviewer also suggested that EPA consider in this source category landfill fires burned in engines as well as the landfill gases burned in flares.

7.2 Accidental Fires

After lengthy discussions, the peer reviewers recommended that EPA revise its findings for structural fires as follows:

- *Include in the inventory an emissions estimate for accidental structural fires.* Despite a lack of extensive testing data, the reviewers strongly recommended that EPA include in the final inventory an estimate of dioxin emissions from accidental building fires. The reviewers thought an estimate was warranted due to the clear potential for dioxin releases

and the large number of fires. Moreover, the reviewers agreed that, by including an estimate of emissions from structural fires, EPA could improve the overall portrayal of dioxin releases to the environment.

The reviewers did not comment on the accuracy of the emissions estimates for motor vehicle fires.

7.3 Landfill Fires

Recognizing that the available testing data suggest that landfill fires may be one of the largest sources of dioxin air emissions, the peer reviewers recommended that EPA revise its findings for this source as follows:

- *Include an emissions estimate in the inventory*. Again, despite limited emissions data, the peer reviewers recommended that EPA include a quantified emissions estimate in the final inventory. EPA can assign an appropriate level of confidence to account for the significant uncertainty associated with such an estimate. (See Section 3.2 of this report for the reviewers' recommendations on revising the "level-of-confidence" categories.) One reviewer suggested that, given the scale of the order-of-magnitude emissions estimate, EPA verify the incidences of landfill fires to ensure that the emissions estimate is as good as possible.

7.4 Forest and Brush Fires

The air emissions estimate for forest and brush fires (i.e., 208 g TEQ in 1995) ranks fourth among the sources EPA quantified in the inventory. The peer reviewers made the following recommendations for this source: (1) given the limited emissions data, EPA may wish to assign a lower confidence level to the emissions estimate (see Section 3.2 of this report); (2) EPA should include open agricultural burning as a separate source category, since releases from agricultural burning were not considered as forest or brush fires; (3) EPA should clarify why the "wood stove approach" for estimating emissions from this source is more reasonable than the "soot-based" and "carbon monoxide" approaches; and (4) if EPA uses the residential wood combustion emission factor for the forest and brush fires, EPA should update this section of the report if the Agency revises the residential wood combustion emission factor (see Section 5.2.1).

7.5 Backyard Trash Burning

Recognizing that the available testing data suggest that backyard trash burning may be one of the largest sources of dioxin air emissions in the United States, the peer reviewers recommended that EPA revise its findings for this source as follows:

- *Include an emissions estimate in the inventory*. Despite limited emissions data, the peer reviewers strongly recommended that EPA include a quantified emissions estimate in the final inventory. As with the emissions estimate for landfill fires, EPA can assign an appropriate level of confidence to account for the significant uncertainty associated with its estimated emissions from backyard trash burning. (See Section 3.2 of this report for the reviewers' recommendations on revising the "level-of-confidence" categories.)

7.6 Uncontrolled Combustion of PCBs

The peer reviewers had no comments or recommendations for this source.

7.7 Volcanoes

The peer reviewers had no recommendations for this source. One reviewer commented that there may be conditions in some volcanoes that form dioxins, but the reviewer noted that volcanoes are not likely to be a major source of dioxins in the U.S.

8.0 REVIEW OF CHAPTER 7, "METAL SMELTING AND REFINING SOURCES OF CDD/CDF"

The following discussion summarizes the reviewers' extensive discussions of dioxin sources specific to metal smelting and refining facilities. The reviewers noted that EPA did not quantify emissions for several source subcategories in this industry.

8.1 Primary Nonferrous Metal Smelting/Refining

The inventory report mentions copper, magnesium, nickel, and aluminum manufacturing facilities, but it fails to make emissions estimates for these sources. The reviewers took exception to this approach and recommended that the Agency revise Chapter 7.1 to include subcategorization by metal, describe process chemistry (where relevant), address how pollution control devices may affect emissions, and make a scoping analysis of all chlorine-based processes in the primary nonferrous metals sector. Specific recommendations for the reviewers' proposed subcategories follow:

- *Copper*. The reviewers recommended that EPA use the available activity data and emissions data to report at least an order-of-magnitude emissions estimate for primary copper smelters. One reviewer suggested that Chapter 7.1 clearly explain why emissions from primary copper smelters are estimated to be significantly lower than those from secondary copper smelters (see Section 8.2.2).

- *Magnesium*. The inventory report presents testing results from a Norwegian magnesium production facility that measured wastewater emissions of 500 grams TEQ per year. The reviewers found this result troubling, especially because the inventory's "General Findings" suggest that all U.S. dioxin sources *combined* release just 20 grams TEQ per year in wastewater. If found to represent U.S. magnesium production facilities, the Norwegian data may significantly alter the emissions inventory. The reviewers recommended that EPA study the production of magnesium in the U.S. to determine whether it is a potential source of dioxins. EPA should (1) find information on the processes used in the U.S., (2) determine whether emission factors from Greenpeace Canada studies (Bramley, 1998) or elsewhere in the literature can be used to estimate releases.

- *Nickel*. The inventory report cites emissions data for two nickel processing technologies used in Norwegian facilities, but it fails to mention whether these emissions data or processing technologies might apply to U.S. sources. The reviewers recommended that EPA investigate U.S. processing technologies (e.g., process chemistry, operating parameters, and pollution controls) and determine whether sufficient data are available for estimating emissions from this source.

- *Aluminum*. The peer reviewers had no comments or recommendations for this source.

- *Titanium*. One reviewer noted that preliminary data suggest that titanium manufacturing facilities may release small quantities of dioxins to the environment and suggested that EPA include these facilities as a separate subcategory of nonferrous metal smelters.

8.2 Secondary Nonferrous Metal Smelting

After discussing EPA's findings for this source category, the reviewers evaluated EPA's estimates of dioxin releases from secondary aluminum, copper, and lead smelters. The reviewers noted that the secondary copper and aluminum smelters rank second and eleventh, respectively, among the air emission sources that EPA quantified. Specific findings and recommendations for these sources follow.

8.2.1 Secondary Aluminum Smelters

Regarding EPA's estimate of dioxin releases from secondary aluminum smelters, the peer reviewers had three recommendations:

- *Explain why CARB and German data were excluded*. According to the inventory report, EPA based its emission factor (i.e., 13.1 ng TEQ per kilogram of scrap feed) on tests of "four facilities with potentially MACT-grade operations and APCD equipment" (page 7-3). However, EPA apparently excluded two data sets that suggest notably higher emission factors: (1) CARB tested two facilities and reported emission factors of 52.2 and 21.7 ng TEQ per kilogram of scrap feed, and (2) German data from 11 tested facilities suggest an average emission factor of 42.0 ng TEQ per kilogram of scrap feed. The reviewers recommended that EPA explain why it excluded the CARB and German data from the emissions estimates.

- *Account for all aluminum scrap*. Several reviewers suggested that facilities other than secondary aluminum smelters may refine scrap aluminum in thermal processes, which may release dioxins. The reviewers suggested that EPA assess potential dioxin emissions from these processes and clearly indicate that secondary aluminum smelters do not process all domestic aluminum scrap.

- *Consider creating subcategories*. The inventory report acknowledges a significant diversity of processing technologies and dioxin emissions among secondary aluminum smelters. As a result, the reviewers recommended that EPA research this industry further and create subcategories (e.g., based on process chemistry, pollution controls), if necessary.

8.2.2 Secondary Copper Smelters/Refiners

Regarding EPA's estimate of dioxin releases from secondary copper smelters, the peer reviewers had three recommendations:

- *Verify that emissions testing data represent the spectrum of sources*. According to the inventory report, EPA used 1985 emissions data from one facility to estimate an emission factor for the entire secondary copper smelting industry. The reviewers recommended that EPA verify that this emission factor is appropriate and explain its judgment in Chapter 7.2.2.

- *Account for all copper scrap*. One reviewer suggested that copper facilities other than secondary smelters process as much as two-thirds of all U.S. copper scrap and indicated that the inventory did not address emissions from these other processing facilities. As a result, the peer reviewers strongly recommended that EPA account for potential dioxin emissions from copper processing facilities other than secondary smelters.

- *Consider other data sources*. One reviewer indicated that a California agency recently detected "high" levels of dioxins in residue ash at a secondary copper smelter, but no reference was provided for this test. Another reviewer noted that residues from many other metals processing sectors likely contain dioxin, but no reference was provided for this either. The reviewers suggested that EPA include these results in the inventory report, because they might lend perspective to the relatively high air emissions data for the subcategory.

8.2.3 Secondary Lead Smelters/Refiners

Regarding EPA's estimate of dioxin releases from secondary lead smelters, the peer reviewers offered only one recommendation:

- *Revise text to indicate factors that affect dioxin formation*. The reviewers suggested that Chapter 7.2.3 of the inventory report indicate that many different factors (e.g., air pollution controls, feed composition, regimes of operating temperatures) affect dioxin emission rates from secondary lead smelters. In light of this, the peer reviewers recommended that EPA revise its statement concerning PVC in lead battery casings to reflect changes between 1987 and 1995 (see page 7-10 of the inventory report).

8.3 Primary Ferrous Metal Smelting/Refining

To estimate dioxin emissions, EPA subcategorized primary ferrous metal smelting as sinter production operations, coke production operations, and electric arc furnaces. Lacking representative emissions data for these sources, EPA estimated order-of-magnitude emissions only for electric arc furnaces. Specific findings and recommendations for these subcategories follow.

8.3.1 Sinter Production

Regarding EPA's estimate of dioxin releases from sinter production, the peer reviewers offered only one recommendation:

- *Consider additional data*. During the meeting, EPA representatives indicated that ongoing U.S. emissions testing data for sinter production differ significantly from European testing data. The EPA representatives and one reviewer agreed that the European data may not represent U.S. sources, because the corresponding sintering technologies differ. The reviewers recommended that, if the ongoing U.S. testing results are published, then EPA explain these differences in the final inventory report. (One reviewer noted that Canadian testing data may be available for sinter production, but a reference was not provided.)

8.3.2 Coke Production

The peer reviewers had no comments or recommendations for this source.

8.3.3 Electric Arc Furnaces

Regarding EPA's estimate of dioxin releases from electric arc furnaces, the peer reviewers offered only one recommendation:

- *Clarify emissions data.* In the inventory report, EPA estimates emissions from electric arc furnaces using a German emission factor and a U.S. activity level. One reviewer suggested that EPA should justify its use of German data by comparing German and U.S. technologies and pollution controls for electric arc furnaces.

8.4 Ferrous Foundries

The peer reviewers had no comments or recommendations for this source.

8.5 Scrap Electric Wire Recovery

The peer reviewers had no comments or recommendations for this source.

8.6 Drum and Barrel Reclamation Furnaces

The peer reviewers had no comments or recommendations for this source.

9.0 REVIEW OF CHAPTER 8, "CHEMICAL MANUFACTURING AND PROCESSING SOURCES"

The following discussion summarizes the reviewers' extensive evaluation of dioxin emissions from chemical manufacturing and processing sources. In Chapter 8 of the inventory report, EPA classifies these sources in four categories, which are further divided into subcategories. The peer reviewers' findings and recommendations for these dioxin sources follow.

9.1 Bleached Chemical Wood Pulp and Paper Mills

When the reviewers discussed this source category, an EPA representative indicated that the activity level does not account for recycling paper, because emissions from the recycling activities are expected to be very low. The reviewers suggested that EPA include these observations in Chapter 8.1 of the inventory report.

9.2 Manufacture of Chlorine, Chlorine Derivatives, and Metal Chlorides

The peer reviewers offered only one recommendation for this category of sources:

- *Consider additional emissions data.* EPA did not include in the inventory an emissions estimate for these chlorine-related manufacturing processes. One reviewer suggested that EPA might be able to make a reasonable emissions estimate based on recent emissions data collected in the United Kingdom (EA, 1997a; EA, 1997b).

9.3 Manufacture of Halogenated Organic Chemicals

In the inventory report, EPA addresses eight source subcategories for halogenated organic chemical manufacturing. The peer reviewers made no recommendations for four of these source subcategories, and they offered the following suggestions for the other four subcategories:

- *Chlorophenols (Chapter 8.3.1).* The inventory document states that "disposal of wastes generated during the manufacture of chlorophenols are strictly regulated and thus releases to the environment are assumed to be negligible" (page 8-10). The document also suggests that effluent limitations will likely reduce releases of dioxins, even though data supporting this hypothesis was not provided. The reviewers took exception to this hypothesis and recommended that EPA use testing data to make such conclusions.

- *PVC (Chapter 8.3.4).* The reviewers agreed and strongly recommended that EPA include in the inventory at least an order-of-magnitude emissions estimate for this source, especially because relevant data seem to be available.

- *Other aliphatic chlorine compounds (Chapter 8.3.5).* One reviewer indicated that studies in the United Kingdom have shown that the manufacture of certain aliphatic chlorine compounds from mixed residue streams in oxychlorinator reactors led to the production of significant amounts of dioxins in waste streams that were subsequently disposed of. The reviewer recommended that EPA determine whether similar practices in the U.S. could lead to releases of dioxins.

- *PCP and 2,4-D (Chapter 8.3.8).* According to the inventory, EPA estimates 25,000 grams TEQ enter "the environment" in PCP-treated wood. The reviewers strongly recommended that EPA highlight this potentially largest dioxin source in the "General Findings" of the inventory. Further, the reviewers encouraged EPA to state clearly in the report that the fate of these dioxins (and other dioxins in reservoir sources) is not known and is apparently covered in another volume of the Dioxin Reassessment. The reviewers also encouraged EPA to adopt a broader uncertainty factor for dioxin emissions from 2,4-D manufacturing processes and for the amounts of dioxins in 2,4-D products.

9.4 Other Chemical Manufacturing and Processing Sources

Although EPA evaluated four source subcategories for these processes, the peer reviewers focused on critiquing the water emissions estimates for municipal wastewater treatment plants (see Chapter 8.4.1). The reviewers made only one recommendation for this source:

- *Include dioxin emissions to water in the inventory summary.* The inventory report indicated that municipal wastewater treatment plants emit between 13 and 163 grams TEQ to water streams annually. The reviewers were troubled by this result, especially because Table 2-2 in the inventory report suggests that only 20 grams TEQ were released to water streams *by all emissions sources combined.* Therefore, possibly the largest source of dioxin emissions to water (i.e., municipal wastewater treatment plants) is not included in

the “General Findings” of the inventory. The reviewers strongly recommended that EPA revise the presentation of Chapter 2 information accordingly. Refer to Section 3.3 of this report for further discussion on this topic.

10.0 REVIEW OF CHAPTER 9, "BIOLOGICAL SOURCES OF CDD/CDF"

The reviewers concluded that Chapter 9 described current knowledge of biological sources of dioxins adequately and reviewed the relevant literature thoroughly. The reviewers noted that this chapter is useful in indicating the potential for transformation and formation of dioxins in the environment. Although the reviewers indicated that a rough order-of-magnitude estimate of dioxin emissions from biological sources would be useful, they agreed that EPA may have too little information to make a reliable estimate.

The peer reviewers offered only one recommendation for the biological sources of dioxins:

- *Provide detailed information on dioxins in ball clay deposits.* The inventory report states that dioxins "were recently discovered in ball clay deposits" (page 9-1), but it fails to provide detailed information on the supporting sampling and analytical results. The peer reviewers and some observers indicated that, if true, dioxins in ball clay deposits would mark new understanding of dioxin sources and could significantly change the inventory. This may be a very important finding, especially if EPA discovers that dioxins in ball clays (if confirmed to be detected) arise from natural sources or are present in large quantities. Because of this, the reviewers recommended that EPA include evidence of dioxins in ball clay deposits in the final report.

11.0 REVIEW OF CHAPTER 10, "PHOTOCHEMICAL SOURCES OF CDD/CDF"

The peer reviewers concluded that Chapter 10 of EPA's report provides valuable information on how photochemical reactions cause dioxins to form, or transform, in the atmosphere. For example, the chapter indicates that photochemical reactions might transform higher chlorinated dioxins to more toxic, lower chlorinated compounds. This finding should be relevant to EPA's analysis of fate and transport in the dioxin exposure reassessment. The reviewers agreed that EPA has too few data to estimate how these sources affect dioxin levels in the environment and therefore made no recommendations for revising this chapter.

12.0 REVIEW OF CHAPTER 11, "SOURCES OF DIOXIN-LIKE PCBs"

In Chapter 11 of the inventory report, EPA identifies, and reviews emissions testing for, several sources that release dioxin-like PCBs. With one exception, congener-specific emissions data were not available for the identified sources of dioxin-like PCBs, and EPA therefore could not estimate emission factors or quantify releases from these sources. EPA did include emissions data for disposal of nonincinerated municipal sludge, a source that has been widely tested.

The reviewers agreed that EPA need not estimate releases of dioxin-like PCBs until the corresponding sources are better characterized, and it offered the following recommendations for revising this section:

- *Revise the "General Findings" in Chapter 11.1.* In the inventory report, EPA states "the widespread occurrence of PCBs is most likely due to the re-release of these compounds from reservoir sources" (page 11-2). Because many potential PCB sources have not been characterized, the reviewers suggested that EPA's conclusion is not supported by available data, and they recommended that EPA revise this "general finding" accordingly.

- *Add sources to the inventory.* One reviewer indicated that European tests have found dioxin-like PCBs in releases from coal combustion, cement kilns, and metal smelting. It is unclear, however, if the European tests include congener-specific results. Nonetheless, the peer reviewers recommended that EPA identify these potential sources in the inventory, even if emissions cannot be estimated.

- *Explicitly evaluate utility boilers that burn PCB-laden wastes.* During the peer review, the reviewers learned that the inventory does not include a potentially significant source of dioxin-like PCBs: utility and industrial boilers that co-fire fuels containing up to 10 percent PCBs. (These sources are apparently exempt from the Toxic Substances Control Act.) The reviewers recommended that EPA include this source in the PCB inventory.

- *Include cross-references.* Chapter 11 of the inventory report presents data for several industrial sources that are described in earlier chapters. The peer reviewers suggested that EPA include cross-references for these sources.

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APPENDIX A

LIST OF EXPERT PEER REVIEWERS

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Dioxin Inventory Peer Review Meeting

Ramada Plaza Hotel Old Town
Alexandria, VA
June 3–4, 1998

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Dioxin Inventory Peer Review Meeting

Premeeting Comments

Alexandria, VA
June 3-4, 1998

Prepared and compiled by:
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Notice

The enclosed comments are preliminary in nature and are intended to initiate and focus meeting discussions. No comments should be considered any peer reviewer's definitive opinion. The final meeting report will synthesize the discussions that occur during the meeting and will include recommendations to EPA.

Patrick Dyke

Pre-meeting Comments on Draft EPA Inventory

Patrick H Dyke
PD Consulting, Oxford, England

The draft report and the CD ROM contain large amounts of information on a complex subject, the review cannot hope to address all the issues and check the detail of all the calculations used. Therefore these comments represent a preliminary review of the information and the approaches used by EPA and should not be taken as definitive.

Where experts in individual sectors make comments on the draft report these will have to be assessed to see how they fit into the overall report and if they are compatible with it. Input from the peer review cannot be expected to substitute for input from experts in the individual sectors and I am sure EPA will be assessing such input.

Heading numbers for the source specific comments are those used by EPA in the draft report for ease of cross referencing.

1 General Method Used to Estimate Dioxin Emissions.

1.1 The criteria used to include/exclude emissions data

It is necessary to consider the data used in the development of emissions factors. EPA rightly note the importance of the variability found amongst plants from the same nominal category of sources. It is unclear in the explanation of the data used (page 2-5) whether all data available was considered – in particular regulatory compliance data and data from overseas. Whilst sampling and analytical practice have improved markedly over the years there is still uncertainty associated with the measurements. Relying on peer reviewed literature probably reduces the available data base and is in itself no guarantee of the applicability of the data (there is often a lack of relevant detail in peer reviewed literature due to constraints

on space). Judgement clearly is needed in the choice and application of emissions data and it is advisable to draw from the widest data base possible for this.

The crucial aspect with data on activity level is finding the appropriate measure. Care must be taken to ensure that the chosen activity statistic matches the emission factor - for example the stack gas volumes produced per unit of feed may be variable for metal processes.

Comments will be made as possible on the choice of data for the individual source categories.

1.2 The method for judging uncertainty and assigning confidence ratings.

Uncertainty is a key issue in the dioxin inventory and it is right that EPA address it. It is becoming international practice to assign qualitative measures to uncertainty of activity statistics and emission factors. The scheme adopted by EPA appears sound.

Developing a range of numbers for the emissions from the central estimate and taking this as the geometric average of a range does not appear to be in line with other international practice and this must be noted when comparing one inventory with another.

1.3 Emission factor approach

It is now established practice to develop inventories based on an emission factor approach. The general approach of developing emission factors for classes of plants where these can be reasonably judged to be distinct is appropriate but the class boundaries may need to be re-examined in the light of additional data.

The approach of estimating some sector emissions based on summing the emissions from measured plants and applying an emission factor approach to the unmeasured plants (page 2-3, 2-4) appears attractive but does require that the plants which are treated individually have measured emissions representative of a year of operation. This will need to be examined on a case by case basis. This approach might weaken the overall inventory if there is great in plant variability that is not being addressed.

1.4 Other general comments

On page 2-9 there is a discussion of inventories of dioxins from other countries. It can be dangerous to make comparisons from one inventory to another without consideration of the country in question (industrial structure and waste management practices for example) as well as the pollution controls in place. It is also clear that the knowledge of dioxin sources continues to increase and older inventories are unlikely to be as comprehensive as newer ones. Therefore covering all the sources found in an old inventory is not the same as covering all the sources.

The most recent inventory for the UK which has not been quoted was published by Her Majesty's Inspectorate of Pollution in 1995[1] and this was summarised in the paper by Eduljee and Dyke[2] which is referenced later in the EPA report. Further UK work has examined the release of dioxins to land and water in the UK[3] [4]. It is important to note that the UK work considered releases to landfill alongside releases to the open environment in line with the UK legal definition of a release to land.

Further work has been carried out in Europe to attempt to estimate emissions in European countries although I am not familiar with all the work and cannot vouch for its accuracy or completeness[5].

I know that new data is being generated that will change emissions estimates and certainly in the UK controls are being placed on sources which will reduce emissions. Emissions from some sectors have been underestimated – for example from the metal sector in the UK – a similar situation occurred in Germany where new data has shown greater emissions from this sector as a whole as new information emerged.

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[1] A Review of Dioxin Emissions in the UK, HMIP/CPR2/41/1/38, 1995 (EPA have copies)
[2] Eduljee and Dyke, An updated inventory of potential PCDD and PCDF emission sources in the UK, The Science of the Total Environment, 177, 303-321, 1996
[3] A Review of Dioxin Releases to Land and Water in the UK, Research and Development Publication 3, Environment Agency, UK, 1997 (EPA have copies)
[4] Dyke, Foan, Wenborn, and Coleman, A Review of dioxin releases to land and water in the UK, The Science of the Total Environment, 207, 119-131, 1997 [summarising the full report]
[5] Identification of Relevant Industrial Sources of Dioxins and Furans in Europe, Report 43, Landesumweltamt Nordrhein-Westfalen, Germany

In general it would be beneficial for the units used to express emissions factors to be consistent throughout the report where possible.

Assuming that non-detect values can be set to zero to estimate emissions will inevitably lead to lower overall estimates and should be treated with some caution. This effect is particularly acute where detection limits are high – for example in the case of some old data or some media. Where many non-detects are found this should be mentioned and considered.

There are places where the terminology could be tightened to add clarity. For example the abbreviation MWI is used for medical waste incinerators and medical waste incineration.

Congener profiles are given and I cannot see a clear explanation of the calculations used. There are several ways of expressing congener profiles. It appears that EPA have used the ratio of the 2,3,7,8 congener to the sum of tetra to octa congeners but there are several data sets missing the totals. Are these then excluded from the calculations? Some explanation would be useful.

Some of the US EPA references appear to be draft. Are these already peer reviewed and not likely to change?

The limited time available makes a detailed review of the report very difficult. Furthermore the data presented on the CD-ROM is not necessarily all that clear and easy to access. There was certainly no chance to examine the congener specific data in detail nor compare congener profiles to other information on similar sources.

If the inventory is to form an integral part of the process of trying to identify a quantitative link between sources and exposure there is a clear need to have a close relationship between observed levels of CDD/F in the environment and in the food chain and the sources that are quantified. It is clear that the sources and their relative importance have changed substantially over the period examined (1987-1995), it is also clear that they will have changed before this and will continue to change substantially after this. Therefore great care must be taken to ensure a good picture of sources that contributed to exposure if we look back to compare body burdens to sources.

2. Overview of Sources

The development of an inventory such as this is a complex task and subject to considerable uncertainty. The approach taken will depend on the use that the inventory is to be put to. The two crucial problems are changes that occur over time with changing practices and the lack of comprehensive data. Although EPA have quantified a large number of sources it is very important that due account is taken in the discussion of the sources that have not been included in the inventory. For those sources where order of magnitude estimates have been made the sum of emissions may be close to or exceed the total of the quantified emissions. Therefore the "inventory", as it stands may only address half of the sources and this must be noted when use is made of it and when the findings are discussed.

There is very little comment on the largest flow of CDD/F that is quantified – that in PCP. Presumably this is assumed to disperse into the environment or be disposed of by a variety of means. Either way it could be significant and should be commented upon.

The term dioxin-like compounds is used in section 2 but it appears that the inventory here only considers chlorinated dioxins and furans, care should be taken to ensure it is clear which compounds are and are not included.

Reservoir sources have largely been excluded from the consideration of sources. It is important to be clear that these sources may be of considerable importance.

The exclusion of landfilled materials from consideration should be assessed against the quality of the landfills in use. This may be particularly relevant for historical sites where leakage may be a problem and contemporary releases may be found of a reservoir source of dioxins.

The addition of new sources to the inventories even now (landfill fires and backyard trash burning for example) indicates that there is still considerable scope for changes to the overall picture and it would be

prudent to acknowledge this clearly. Any further information on the CDD/F in ball clays would be useful in this context – perhaps some estimate of the total amount of CDD/F so far identified.

3 Source Specific Comments

3.1 Municipal Waste Incineration

CDD/F air emissions

As EPA note the formation and emission of CDD/F from the incineration of MSW has been intensively studied. It is therefore more appropriate to consider emissions from subsectors to the extent that this is possible and to reflect the greater knowledge in reduced ranges of uncertainty. It is also clear that the industry has made substantial improvements to emissions as knowledge has been gained.

Characterisation of the industry activity is better than for most sectors and there are more emissions data. EPA might want to consider using test data from the literature and overseas to make emission factor estimates for sectors of plants where US data is lacking and to check on areas where the number of tests is small.

The terminology could be tightened in terms of plant descriptions eg page 3-6. Care should be exercised to distinguish between dry scrubbers (known in the UK at least as semi-dry or spray dry) and dry sorbent injection (known in the UK as dry scrubbing). The text suggests dry scrubbers are used only with ESPs and that wet scrubbers are always two stage, this is not the case. In Europe many older systems used wet scrubbers but in conjunction with hot-side ESPs and dioxin control was poor.

The assumption that emission factors remain the same for each class from 1987 to 1995 may not take account of improvements to operational practices. Certainly in the UK we have seen improvements to combustion control on existing plants prior to full-scale upgrading of pollution controls. These improvements decreased emissions of combustion related pollutants. Has a similar effect been seen in the US? A further possible effect of improved operation would be the reduction in variation found in stack

emissions at single plants. Modern plants should be operating closer to a steady state than was found in the past.

Time constraints have prevented a close examination of the emissions factors used or the categories of plant selected but this would form a useful discussion at the meeting.

CDD/F in Ash

Whilst the CDD/F in ash do not necessarily represent as direct a release to the environment as CDD/F in water or air emissions EPA have attempted to quantify them. It can be expected that levels of CDD/F will vary from one type of plant to another depending on the combustion system and the pollution controls applied. The overall production of CDD/F is influenced by the combustion efficiency and the formation in the system after the combustor, the partitioning of CDD/F formed will depend on the pollution controls. These estimates could be further refined if this was thought warranted and a note could be made that differences could be expected from one system to another. UK experience showed considerably reduced total formation for modern systems compared to old plants[6].

3.2 Hazardous Waste Incineration

The section on hazardous waste incineration would be improved by some discussion of the history of controls on such incinerators. Since low emissions factors seem to have been applied to the industry in 1987 and 1995 I would be interested to know how the technology has evolved or from when the current technologies were used. This is relevant for the 1987 estimate and I would also like some indication that the tested facilities adequately represent the full stock of existing plants.

There appears to be come confusion in the terminology – on pages 3-14 and 3-19 MWIs are mentioned.

[6] A Review of Dioxin Releases to Land and Water in the UK, Research and Development Publication 3, Environment Agency, UK, 1997 (EPA have copies)

EPA mention the estimates of emissions made by the Office of Solid Waste using a different technique but do not show the results. Can we see these please.

The section on boilers and industrial furnaces using waste would be strengthened if there was some indication of the types of waste that are burned and some indication of the air pollution controls applied. In particular was the practice in 1987 sufficiently similar to that in 1995 to use the same emission factors.

3.3 Medical Waste Incineration

It is important to consider the conditions found at medical waste incinerators during stack tests in order to assist the extrapolation of results to untested plants. In particular the feed of waste material. In order to get an emission factor data is needed on the emission concentration and the amount of waste fed during the test period. It is notoriously difficult to establish waste feeds and it is possible that the design capacity will not provide a good measure. Since MWIs use support fuel it is conceivable that reduced waste feed rates and increased supplementary fuel feed rates in test periods can give low calculated emission factors. Some information on this could be gathered by checking the specific production of stack gas per unit of waste feed. The range of the results could indicate whether similar amounts of support fuel are in use and may show outlying results which may suggest errors in the measure of waste feed.

Test data used to characterise the 1987 stock is presumably more recent than 1987 and therefore may represent the better quality end of the range. It may not be possible to make a quantitative estimate of the change in emissions that could be expected if older poorer plants had formed a larger fraction of the stock but it may be worth considering a mention of it.

There appears to be an error 87est.xls, it looks like the column heading for E in “87 Emissions Estimate MWI new” should be thousand tonnes not million tonnes.

Classifying MWI emissions into groups based on residence time is superficially attractive but there is insufficient data available to support this. Experience tends to suggest that the factors controlling the emissions of CDD/F are too numerous and complex to simplify in this way. Prior to designers attempting

to control CDD/F in the knowledge of some of the factors controlling the emissions I think there is little chance of making such groupings.

Due account of the operational regime needs to be made. Studies on various incinerators have shown considerable disadvantages in terms of CDD/F production to intermittent operation. Any influence of this can be difficult to detect when stack tests are confined to steady state operation. Has this been adequately addressed given the batch-wise operation and small scale of many of the plants in this sector?

I am not clear on the overlap or otherwise of the emissions data used by the different groups to make their estimates. For example did EPA ORD use the AHA database or was it found to be lacking? There are considerable differences in the selected emissions factors which I would like to examine in more detail.

3.4 Crematoria

Additional test data is available from the UK on two cremators[7]. Cremators in the UK were required to improve combustion conditions and to increase gas residence time in order to reduce emissions. Tests were carried out on an older system (preheat to 650°C 1 second residence time secondary chamber, air ejector exhaust) and a modified system with improved controls and 2 second residence time at 850°C. Emissions were higher than expected at 25-45 ng TEQ/Nm^3 (11% O2) for the modified unit and 42-71 ng TEQ/Nm^3 (11% O2) for the older unit. The addition of a larger quantity of support fuel may have diluted the exhaust gas from the modified unit. Using the gas generation rates given by Bremmer et al (1994) emissions factors of 70-80 micro g per body can be calculated from the mean emission concentration[8].

It is to be expected that there will be considerable variation between cremator designs and due to operational differences. EPA should consider whether they need to re-evaluate the emissions in the light of this data and the Jager data.

3.5 Sewage Sludge Incineration

In the UK and Europe the trend has been away from multiple hearth incinerators towards fluidised beds. Emissions controls have also been improved and would now usually include wet scrubbing as well as electrostatic precipitators or fabric filters. Emissions tests in the UK showed much higher emissions for multiple hearth plants[9]. It is not possible to see if EPA found a similar pattern in the US. If there is a clear difference it may be worth considering breaking down the activity into different plant types.

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[7] Investigation of Pollutant Emissions from Crematoria, LR908 (PA), Warren Spring Laboratory, UK

[8] A Review of Dioxin Emissions in the UK, HMIP/CPR2/41/1/38, 1995 (EPA have copies)

[9] A Review of Dioxin Emissions in the UK, HMIP/CPR2/41/1/38, 1995 (EPA have copies)

3.6 Tyre Combustion

The combustion of tyres does not appear to be a significant source of CDD/F. The tests referenced in the UK were for modified small-scale boilers and are not thought to be representative of dedicated tyre units or co-combustion in large plant. The only point that may be worth considering in addition to EPA's note that most tyres go to co-combustion plants, is that the composition of tyres may be changing with a move away from natural compounds to synthetics.

3.7 Pulp Mill Sludge Combustion

If EPA are satisfied that the tested plants are representative of the plants in the US the approach appears sound.

3.8 Biogas Combustion

There has been little interest in examining this source world-wide and it is not thought to be major. Although I am unfamiliar with the data presented by Schreiner care should be taken in converting concentrations to emission factors to ensure that the effects of gas conditions are taken into account. Presumably someone could confirm the estimates of amounts of sludge digested.

4 Combustion Sources of CDD/CDF

4.1 Motor Fuel Combustion

It seems appropriate to subdivide this category as EPA have done. There might be a case for putting some bounds for non-road vehicle use, at least in terms of quantifying the activity (total fuel consumed perhaps) and if this is large then considering applying the most appropriate emissions factors to get an order of magnitude estimate of potential emissions. It has been suggested in the past that any emissions from

agricultural machinery may have an elevated impact due to proximity to agricultural produce and therefore a route into the foodchain.

For leaded fuel I would like to examine the Bingham study in more detail to see whether the reviewers feel it should be used to calculate the average emission factor.

There is considerable uncertainty for heavy duty diesel engines emissions factors and here the EPA have selected a single emission factor rather than take a mean of studies. I would like to discuss the pros and cons of such an approach.

4.2 Wood Combustion

4.2.1 Domestic

The calculations for residential wood combustion appear to neglect the data contained in the Dutch inventory study[10] which include studies on wood stoves and on fireplaces. Whilst woodstoves gave emission factors between 1 and 3.3 ng TEQ /kg fireplaces fared worse and factors of 13 and 28.5 ng TEQ/kg are reported for two tests. Tests in Germany[11] have provided concentrations of CDD/CDF in emissions from domestic combustion of various fuels including wood in stoves and fireplaces (0.53 ng TEQ/m^3 and 0.19 ng TEQ/m^3).

Further EPA note that the inclusion of waste materials or treated wood can raise the emissions very considerably but no explicit account is taken of this.

I feel there may be a case for considering the possibility of higher emissions from this sector.

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[10] Emissions of Dioxins in the Netherlands, TNO/RIVM, report 770501018 (EPA have copies)
[11] Measures to Reduce the Emission of Dioxines and Furans in the Federal Republic of Germany (EPA reference as Umweltbundesamt 1996).

4.2.2 Industrial

Industrial wood combustion takes many forms from large scale dedicated boilers to small hand stoked units based at joiners and furniture factories. The tests used by EPA to estimate an emissions factor do not appear to include either small-scale facilities or facilities combusting treated wood waste. I would like to see more information on the use of wood wastes from manufacturing facilities rather than saw mills. Consideration may want to be given to emissions factors determined in the UK, Netherlands and in Germany for such plants. The tests on wood soaked in sea water were excluded – is this appropriate?

It would be useful to include a cross reference to the section on black liquor boilers.

4.3 Oil Combustion

The derivation of the emission factor for industrial oil use by taking the mean of the EPRI data and the median data from EPA work may underestimate the emissions factor. It would be worth examining the data used to derive the median figure for the EPA work.

If a considerable quantity of oil is used in marine applications where chloride and other contamination may be expected it may be worth considering the Dutch emission factors.

No consideration appears to have been given to the combustion of used/recovered oil.

4.4 Coal Combustion

4.4.1 Industrial/Utility

Further UK data is available as summarised in the UK inventory study. Tests have been carried out on several large-scale coal burning boilers in power plants and industrial boilers[12][13]. Power generation plants gave emission factors between 0.06 and 0.32 ng TEQ/kg. For industrial/ commercial plants emissions factors ranged from 0.4-4.8 ng TEQ/kg. The applicability of UK data to the US is not clear but it may be worth noting that higher emissions have been found.

4.4.2 Domestic/ Commercial

Although no US data could be found EPA note that there are reports of CDD/F emissions from domestic coal combustion. Further data is available from Germany in the Umweltbundesamt report in terms of emission concentrations. Whilst the coal type is likely to influence the emissions it is also likely that the variation in equipment types may not be too great and perhaps the emissions will be similar.

As for domestic wood combustion the practice of burning other materials (waste for example) could have a real impact on actual emissions in comparison to emissions under laboratory conditions.

5. Combustion Source: Other High Temperature Sources

5.1 Cement Kilns

[12] Organic Compounds from Coal Utilisation, Sloss & Smith, Report IEACR/63, IEA Coal Research UK, 1993
[13] Emissions of Environmental Concern from Coal Utilisation, C/00/00047/00/00, July 1994, Coal Research Establishment, UK

The incineration of waste in cement kilns is a highly contentious issue and appears to be surrounded by considerable uncertainty. In the UK and Europe data appears to suggest that there is little reason for distinguishing between kilns permitted to burn wastes and conventional kilns in terms of CDD/F emissions. I am not able to tell whether practices are sufficiently different in the US to mean that they can be so distinguished.

In the UK we subdivide kiln technology to include a semi-wet classification. There are suggestions that wet kilns with longer residence times are more suited to waste combustion. EPA may want to ensure that they have picked up enough detail on the industry and technology descriptions.

Is it appropriate to consider light weight aggregate kilns?

Costs of fuel are thought to make up about 30% of operating costs in the UK (cf *most* of the cost page 5-3)

Are non-hazardous wastes considered?

Most kilns are thought to use hot-side ESPs (page 5-4) since this appears to have a great influence on the emissions of CDD/F has this been verified? In Europe there has been much discussion about the influence of raw materials on the formation of pollutants including CDD/F. In general the picture given is that well controlled kilns appear to emit very similar amounts of CDD/F when burning permitted wastes as when operating under baseline conditions.

Given the findings of the parametric study and the confusion on this issue I would like the chance to discuss the demarcation of the categories at the meeting.

A very preliminary examination of the spreadsheet data suggests that the kilns burning hazardous waste results are dominated by 2 plants. Presumably these reports have been considered, is there any indication of why emissions should be higher?

There is literature data available on emissions from cement kilns – has this been assessed to help address some of the uncertainty?

CKD

The discussion of CKD is interesting but appears a little unclear in places. It is not clearly stated that the results discussed at the bottom of the page refer to kilns burning hazardous waste (as opposed to all kilns) and over the page I think the next part refers to results if non-detected values had *not* been excluded.

The great influence of the possible outlying result confirms the non-uniformity of the data. Given this I would value the chance to discuss the data and inferences with EPA and the panel.

5.2 Asphalt Mixing Plants

This section appears reasonable in the absence of better data. Presumably EPA have satisfied themselves that industry practices are not likely to lead to emissions much greater than found in Europe.

5.3 Petroleum Refining Catalyst Regeneration

Although there is a discussion here there seems to be no conclusion unless it is the implicit one that there is no release. Some outline of why this is so should be added. Levels in some samples of liquids appear high (57.2 ng TEQ/l.)

5.4 Cigarette Smoking

Cigarette smoking is more likely to be an issue in the exposure assessment given the much closer connection between emission and exposure than for most sources.

5.5 Brominated Flame Retardants

Although this section concludes that no estimates can be made it is perhaps worth ensuring that mention is made of brominated dioxins and furans as a potential issue. More information on the potential importance

of sources of these compounds might be grouped together rather than as a single section in the body of the report. There has been some European work on these issues.

6 Combustion Sources of CDD/CDF: Minimally Controlled and Uncontrolled Combustion Sources

6.1 Landfill Gas

There may be some information on the production and use of landfill gas available as a result of work on greenhouse gases and methane.

It should be noted that the German work presents concentrations in the exhaust gas rather than the raw gas and therefore emission factors will be higher. UK work found levels up to 1 ngTEQ/m^3 in exhaust gases from landfill gas engines.

6.2 Accidental Fires

This is an important and potentially significant section. The range and nature of the fires that could produce CDD/F is very large and includes not only structure and vehicle fires but chemical accidents and the like. My understanding of the study by Carroll was that it considered only the contribution of PVC in house fires to CDD/F production and therefore made no attempt to examine CDD/F from other sources.

The studies are difficult to establish and the results difficult to interpret. It would improve the overall picture if at least an order of magnitude estimate could be made to view alongside the other poorly quantified sources.

Landfill fires may also be significant and will depend to a large extent on the landfilling practices in place.

6.4 Forest and Brush Fires

EPA may want to consider the data from the Netherlands on open fires as for domestic wood combustion.

Are there significant open agricultural burning practices aside from brush burning?

6.5 Backyard Trash Burning

This appears to be a potentially significant source of CDD/F. It warrants further examination and testing. Some information on the prevalence of this activity in the past (presumably more so) and an indication of the related activity of apartment incinerators (not too different from barrel burns perhaps) would be useful. Although there is very little data to go on it may be justifiable to include this in the inventory.

6.7 Volcanoes

Whilst the data don't show this to be an obviously large source there may be the potential for particular conditions to combine to make some events possible sources of CDD/F. I am not an expert on volcanoes but would expect a wide range of conditions and variable composition of materials to be involved.

7. Metal Smelting and Refining Sources of CDD/F

7.1 Primary non-ferrous metal smelting/refining

Of the processes mentioned it appears that the production of magnesium should be considered and the potential for the sort of releases found in Norway assessed.

7.2 Secondary non-ferrous metal smelting

In general secondary processes have caused more concern due to the nature of the raw materials and processes. No mention is made in the introduction of the use of chlorine gas or of hexachloroethane in the metal purification processes. The use of HCE has been associated with CDD/F formation in Europe.

The presence of CDD/F in collected residues should be considered. These residues may be disposed of or may form feed stock to other metal recovery processes. There may be considerable flows of CDD/F in them.

7.2.1 Aluminium

A major factor in the emission of CDD/F is the air pollution control applied at the facilities and details are lacking in the text. What are the types of air pollution controls applied across the industry?

Emission factors may be better expressed on a per unit of output if data is more readily available for this than mass input which could include dross and other non-aluminium materials. Care is also required to ensure that all the steps that could lead to emissions are picked up (for example a pre-cleaning step followed by smelting).

The selected emission factor seems to be low given the additional data from CARB and Germany. It may be worth considering whether the production processes have altered since 1987 – have there been additional controls fitted for example. Is the additional aluminium processed by other sectors (page 7-5) addressed?

7.2.2 Copper

Given the magnitude of the estimated emissions and the reliance on data from a single plant it would be worth introducing and considering European tests for comparison.

As for aluminium a considerable amount of copper is processed elsewhere and this should be addressed if there is a CDD/F source.

7.3 Primary Ferrous Metal Smelting

7.3.1 Sintering

It is appropriate to consider the additional Canadian information provided by Raouf Morcos and to encourage EPA to make an estimate of emissions. The sintering of iron ore has been found to be a potentially significant source in Europe. Additional test data is available from the UK and experts should be able to determine the similarity between US and European practices with regard to use of dross. UK plants are at the lower end of German data and this has been attributed to the exclusion of chlorinated cutting oils etc which were thought to lead to the highest levels found in Germany.

7.3.2 Electric Arc Furnaces

UK data show 59 g TEQ in the filter residues of electric arc furnaces in the UK[14] where a production of 4.2 Mt of steel was reported by electric arc furnaces. A comparison of the practices and air pollution controls used in the US and Germany would be useful.

7.5 Scrap Wire Recovery

It appears that some effort to quantify the extent of this type of operation is justified.

[14] A Review of Dioxin Releases to Land and Water in the UK, Research and Development Publication 3, Environment Agency, UK, 1997 (EPA have copies)

8 Chemical Manufacturing Processes

8.1 Bleached Chemical Wood Pulp and Paper Mills

The section appears to be good. This is not my area and I would like to be reassured that changing technology has not altered the balance of congeners such that measuring only the tetra substituted ones can be sufficient. There appears some suggestion that other congeners are now being found in the sludge (page 8-2).

8.2 Manufacture of Chlorine etc

EPA acknowledge the potential for CDD/F to be formed in the process but do not make any estimates. Two estimates have been made to give an indication of potential for releases in the UK[15][16], these could be considered. Releases were estimated at 1.5-6 g TEQ/y for a production capacity of 790,000 t. Further information may be available from the UK and elsewhere in Europe should EPA want to consider the source further.

PCBs: Estimates of releases of CDD/F from PCBs depend on the TRI data. Is this adequate?

8.2.4 PVC

No information is provided here on the process or industry structure. Coupled with information on the handling of in process materials and wastes this might help to increase the understanding of analytical data which is presented.

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[15] A Review of Dioxin Releases to Land and Water in the UK, Research and Development Publication 3, Environment Agency, UK, 1997 (EPA have copies)
[16] Regulation of Dioxin releases from the Runcorn operations of ICI and EVC, Environment Agency, 1997, UK

There is additional information available, for example on the levels of CDD/F in PVC was published by Wagenaar[17] showing non detects for most congeners. European plants have provided more information also such as Norsk Hydro[18].

EPA are intending to include further results of the Vinyl Institute characterisation programme prior to issue of the report, providing this work meets the criteria laid down it should provide the best information from which to make estimates.

Other Aliphatic Chlorine Compounds

EPA may want to consider whether there is production of aliphatic chlorine compounds using oxy-chlorinators and mixed by-product feeds, in the UK such a practice had been found to lead to CDD/F formation and discharge in wastes (see [15, 16]).

Has the combustion of solvent vapours been considered?

Pesticides

Whilst many pesticides have been withdrawn is it possible to determine whether in 1987 any containing CDD/F were in use and if so what releases might have been expected?

The estimates for release in 2,4-D are assigned High confidence ratings. Are the exclusion of OCDD and OCDF and the possible presence of CDD/F below the seemingly high detection limits an issue?

[17] Analyses of PCDDs and PCDFs in Virgin Suspension PVC Resin, Wagenaar et al, Organohalogen Compounds 27, p72, 1996
[18] PVC and the Environment 96, Norsk Hydro, Norway

8.4.1 Municipal Waste Water Treatment Plants

The discharge of CDD/F in waste water will depend on the degree of treatment applied, probably the extent to which solids are removed from the water discharge. I do not know to what extent the data available are representative of the practices in the US. An estimate could perhaps be made by examining data on suspended solids loadings in discharges and the levels of CDD/F on solids.

For the solids data appears to be good. There is some indication that levels in Europe have been falling and it is not clear why the pattern should be different in the US.

Median values are used to generate the average concentration. Is this more appropriate than mean values in this case?

8.4.4 Textile Manufacturing and Dry Cleaning

Data is discussed to support the idea that CDD/F enter these processes with dyes and PCP on garments and are not formed. However no estimate is made of releases from dry cleaning nor any description of where the material ends up in the US. It is not possible to tell if the source is significant.

9 Bioformation

Is there any consideration of the mass balance studies that have been reported on humans[19], cows and laboratory animals?[20] One of these may show formation from technical PCP and not from purer PCP. It is worth perhaps considering whether the contaminants in PCP may be more important in this respect than the PCP and whether this may influence the interpretation of other data on formation under controlled conditions.

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[19] Human Fecal PCDD/F excretion exceeds the dietary intake, Schrey P, et al, Organohalogen Compounds 30, p51, 1996

[20] PCP as a source of dioxins and furans, Feil V J, Tiernan T, Organohalogen Compounds 33, p353, 1997

10. Sources of PCBs

There is information in Europe that suggests PCBs may be emitted from a variety of processes. It is not clear to what extent these emissions are re-emitted PCB that is in the environment but emissions factors for processes including metal works and coal combustion have been produced[21]. If these are valid significant quantities of PCB may be being released from these processes. Further PCBs may be expected to be emitted from the management of waste contaminated at low levels and from reservoir sources.

The inventory is very limited and attention perhaps should be given to other potential sources. Many experts expect PCBs to be formed in processes along with CDD/F. The inventory will need to be strengthened.

[21] Technical Paper to the OSPARCOM-HELCOM-UNECE Emissions Inventory of Heavy Metals and Persistent Organic Pollutants, TNO, 1995

Raouf Morcos

Dioxin Inventory Peer Review
(Pre-meeting comments)

1. In general, the method used to estimate dioxin emission is reasonable in terms of the criteria used to include emissions test data and judging uncertainty and assigning confidence ratings as well as for the emission factor approach.

2. see attachment

3. Yes, the overall observations and findings presented in chapter 2 are reasonably developed from the evidence.

4. Suggestion for additional sources to be addressed in the document: releases of dioxins and furans from the use of pesticides and wood preservatives. The use of these substances will probably release to soil a significant amount of dioxins and furans that justifies its inclusion in this study.

Chapter 3. Waste Incineration

Issue	Source: MSWI - Mass Burn (MB)
Is the description of the technology complete and accurate ?	Yes:
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes: mass burn, modular, RDF
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	CR: "Medium": Ok
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR: "Medium" for Emission factors: Ok [11 out of 113 tested]
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Sector regulated in 1995. At full compliance the yearly emission will be 24 g TEQ

Issue	Source: Hazardous Waste Incineration
Is the description of the technology complete and accurate ?	Yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes (Tested: 10 Rotary, 4 Liquid Injection, 2 Fixed Hearth, 1 Fluidized Bed)
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	3.8 ng TEQ/kg waste feed [ND = 0]
Are the activity estimates reasonable and well documented ?	yes
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	17 out of 162 tested Emission Factor " medium" confidence rating Activity Level " high" confidence rating YES

Have the suggested alternative approaches been described clearly and appropriately evaluated ?	yes

Issue	Source: Medical Waste Incineration
Is the description of the technology complete and accurate ?	Yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes (97% Modular Furnaces with controlled air, 2% MF with excess air, 1% rotary kilns)
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	19 tested/ 2375 facilities
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	low [ok]
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	further assessment of the releases will be carried out as a result of the new standards

Issue	Source: Crematoria
Is the description of the technology complete and accurate ?	“cold” and “warm” types
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Ok
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	yes; confidence rate high

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR: for emission factor : Low (reasonable) CR: for activity level: high (reasonable)
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Sewage Sludge Incineration
Is the description of the technology complete and accurate ?	3 types: multiple hearth, fluidized bed and electric furnaces.
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	MH: 2 tested; FB: 1 tested + 13 tested by association
Are the activity estimates reasonable and well documented ?	yes, based on survey for rule making (High)
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	yes, CR for emission factor “medium” and High for activity level; both reasonable.
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Tire Combustion
Is the description of the technology complete and accurate ?	within the context, yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	1 facility tested,
Are the activity estimates reasonable and well documented ?	medium, ok

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	low, yes, resonable
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Combustion of Sludge at P&P Mills
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Not applicable
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	industrial wood combustion be used instead: OK

Issue	Source: Biogas Combustion
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Not applicable
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	

Are the activity estimates reasonable and well documented ?	not available
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	not included in national inventory

Chapter 4: Power/energy generation

Issue	Source: Motor Vehicle Fuel Combustion
Is the description of the technology complete and accurate ?	yes, in as much as the different types of tests: new vs old cars; leaded vs unleaded gasoline
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Leaded gasoline tail pipes tested in Sweden, unleaded gasoline: ND no testing in US for cars Diesel truck tested
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Tunnel study: OK
Are the activity estimates reasonable and well documented ?	14% diesel fueled trucks - High confidence rate: OK
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	leaded gasoline:low: Ok Unleaded gasoline: low; Ok diesel: low Ok
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	yes
Issue	Source: Wood Combustion
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Subdividing into residential & industrial is reasonable
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	yes
Are the activity estimates reasonable and well documented ?	residential: CR High - OK industrial: CR High - OK (based on gov't survey)
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	residential: low CR, 2 tested in Europe industrial: medium, Ok (Emission factor not for wood containing elevated Chlorine content)

Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Oil Combustion
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Subdividing the sector into Residential/Commercial & Utility/Industrial is reasonable
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Residential/Commercial: :no stack tests
Are the activity estimates reasonable and well documented ?	Utility/Industrial: CR: “High”, is reasonable
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	Residential/Commercial: no national emission estimates are proposed at this time; Utility/Industrial: CR for emission “Low”, combination of EPRI and EPAs
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Coal Combustion
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	88% used by electric utilities;
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	yes for utilities; no estimates for residential: no measurements in US

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	Activity level CR: “High” is reasonable Emission factor CR: “Medium” Ok, based on recent testing in US facilities by EPRI
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	for residential: no estimates in US

Chapter 5: Combustion Sources of CDD/CDF

Issue	Source: Cement Kilns
Is the description of the technology complete and accurate ?	Yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Subdividing this sector into Kilns burning hazardous waste & Kilns not burning hazardous waste is reasonable
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Tested: 12 kilns [waste] & 11 kilns
Are the activity estimates reasonable and well documented ?	CR is "High", based on recent survey data: is reasonable
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR is "low" for emission factors: 6% kilns tested and may not be representative of normal operating conditions
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	no distinction between the 2 categories. 1996 EPA proposed revised Standards for Cement kilns burning waste: 0.2 ng TEQ/dscm 7%O_2

Issue	Source: Asphalt Mixing Plants
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	No test in US, some in Europe
Are the activity estimates reasonable and well documented ?	estimates are reasonable
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ? Have the suggested alternative approaches been described clearly and appropriately evaluated ?	n.a.; no estimates for national inventory because of lack of US measurements.

Issue	Source: Petroleum Refining Catalyst Regeneration
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	n.a.
Are the activity estimates reasonable and well documented ?	n.a.
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	n.a.
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	further studies under regulatory investigation

Issue	Source: Cigarette Smoking
Is the description of the technology complete and accurate ?	n.a.
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	CR: “High” is reasonable
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR: for emission factor “Low” is reasonable

Have the suggested alternative approaches been described clearly and appropriately evaluated ?	significance due to direct exposure

Issue	Source: Pyrolysis of Brominated Flame Retardants
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Insufficient data to derive emission estimates

Issue	Source: Carbon Reactivation Furnaces
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	yes
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR: Emission factor “Low”: 1 facility tested; CR: Activity level “low” is OK

Have the suggested alternative approaches been described clearly and appropriately evaluated ?

Issue	Source: Kraft Black Liquour Recovery Boilers
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	CR “High” is reasonable: based on recent industry survey
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR emission factor “Medium” is reasonable (test made at 6 US facilities)
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

Issue	Source: Other sources
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?

Have the suggested alternative approaches been described clearly and appropriately evaluated ?

Chapter 6: Combustion Sources of CDD/CDF

Issue	Source: Combustion of Landfill Gases
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Inadequate data for development of national emission estimates

Issue	Source: Accidental Fires
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	

Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Inadequate data for development of national emission estimates: Ok

Issue	Source: Landfill Fires
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Inadequate data for development of national emission estimates: Ok

Issue	Source: Forest & Brush Fires
Is the description of the technology complete and accurate ?	n.a.
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	CR “medium”: is reasonable

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	yes, reasonable
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Wood stove approach is acceptable, CR is "low" Ok

Issue	Source: Uncontrolled Combustion of PCBs
Is the description of the technology complete and accurate ?	accidental combustion of electrical equipment containing PCB
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Inadequate data for development of national emission estimates: Ok

Issue	Source: Volcanoes
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	

Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	volcanoes do not appear to be a source of CDD/CDF release to the environment

Chapter 7 - Metal Smelting and Refining

Issue	Source: 1ry non-ferrous metal smelting
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	N.D.
Are the activity estimates reasonable and well documented ?	
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	Inadequate data for development of national emission estimates: OK

Issue	Source: 2ry non-ferrous smelting: Al
Is the description of the technology complete and accurate ?	description of technology is complete and accurate
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	yes
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR “Low” for emission factors [4 tested]:Ok CR “High” for activity level: Ok

Have the suggested alternative approaches been described clearly and appropriately evaluated ?	n.a.

Issue	Source: 2ry non-ferrous smelting: Cu
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	n.a.
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	yes, CR “High” Ok
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR “Low” for emission factor Ok [1 tested}
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	n.a.

Issue	Source: 2ry non-ferrous smelting: Pb
Is the description of the technology complete and accurate ?	yes
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	CR “Medium” Ok

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR “Medium” for emission factor [3 tested] Ok
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	2ry lead smelters regulated in 1995

Issue	Source:1ry ferrous metals smelting
Is the description of the technology complete and accurate ?	sintering, coke prod., electric arc furnaces (EAF)
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	Yes
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Sintering: not tested in US, yes in Europe Coke: not tested in US, yes in Europe EAF: not tested in US, yes in Europe
Are the activity estimates reasonable and well documented ?	sintering: n.a. coke: n.a. EAF: n.a.
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	Sintering: n.a. coke: n.a EAF: n.a
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	sintering: not in inventory [estimates available] Coke: not in inventory [estimates available] EAF: not in inventory [estimates available]

Issue	Source:
Is the description of the technology complete and accurate ?	
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	

Are the activity estimates reasonable and well documented ?

Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?

Have the suggested alternative approaches been described clearly and appropriately evaluated ?

Chapter 8. Chemical Manufacturing and Processing Sources

Issue	Source: Bleached Chemical Wood Pulp and Paper Mills
Is the description of the technology complete and accurate ?	not described
Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?	
Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?	Yes
Are the activity estimates reasonable and well documented ?	CR: “High” is reasonable
Are the confidence ratings assigned for the emission factor, activity level and overall emission estimates reasonable ?	CR: “High” for emission factor: Ok
Have the suggested alternative approaches been described clearly and appropriately evaluated ?	

William Randall Seeker

Premeeting Comments

by W.R. Seeker, Energy and Environmental Research Corporation

These comments represent preliminary comments on the April 1998 Draft of "The Inventory of Sources of Dioxin in the United States". The focus of this review has been on the general approach and the waste combustion inventory for each source however I have reviewed and commented on all sources covered in the report. These comments represent preliminary comments, reactions, and questions raised by my independent review of the draft and could be modified based upon discussions with other panel members and clarification by EPA during the workshop. In general I found the report to well written, comprehensive, consistent, and well documented. The report is clearly a culmination of a substantial amount of work and the EPA is to be congratulated on their efforts.

Comments Relative to Chapter 1.0 "INTRODUCTION"

1.1 The toxicity equivalence factors discussion should also include the latest World Health Organization assessments of TEF which include a breakout of different toxicity factors for mammals, fish and birds.

1.2 A glossary of terms and terminology would be helpful. In addition a list of the chemical compounds used in the report along with their chemical composition is recommended.

Comments Relative to Chapter 2.0 "OVERVIEW OF SOURCES"

2.1 The confidence rating scheme and assignment of a range of a possible emission estimate based upon this confidence rating appears to be rather arbitrary and not necessarily a true reflection of the uncertainty in the inventory. There is no scientific basis for this range presented in the report but rather it appears to be largely arbitrary and not well defended on a scientific basis. The uncertainty range could in fact be much larger for those sources where the activity and emissions factors are neither well established. This is particularly true when it is recognized that one source with very high emissions can easily dominate the national emission levels. A more definitive range could be developed for those situations where there is medium to high confidence using a more statistical and engineering assessment approach. A better development of the uncertainty range is recommended.

2.2 The establishment of clear time frames for the annual emission estimate is a significant improvement in the presentation of the data. This approach could be further extended with an inclusion of expected trends in the future. These trends are important to policy makers who will focus on the highest priority sources for future regulatory actions. In those instances where a new regulation has already been promulgated (e.g., Municipal solid waste and medical waste incinerators) and EPA has officially established a regulatory impact analysis it is appropriate to indicate in this summary chapter the national inventory expected in the five year time frame (year 2000). This trends analysis would allow the policy makers to see the future needs for regulatory or policy development.

2.3 The statement that procedures and results of the U.S. Inventory was consistent with national inventories for several European countries was not convincing. A comparison of emissions factor used for each source would be more appropriate than national average yearly estimates.

2.4 The use of an order of magnitude calculation for sources that are poorly characterized is useful to at least get a sense of the importance of every source even if it is only a rough estimate. It is critically important to attempt to define the emissions contribution potential of these other sources. However, the rounding of the estimates to the nearest order of magnitude to

emphasize the uncertainty might not be a good reflection of the uncertainty against other sources that are both characterized and uncharacterized. A number of alternative schemes should be considered such as the analysis of the potential range of emissions given the current understanding about the sources. At least some type of range of uncertainty should be attempted whenever possible. For example is a source category with a rough order of magnitude estimate of 51 g per year as important to investigate as a source with a rough order of magnitude of 499 g per year or can we say more about the range of uncertainty that both have a rough estimate of 100 g per year? Given the apparent relative importance of some of these sources such as shown in Table 2-5, it is clear that further analysis of the potential range should accompany the rough order of magnitude analysis.

2.5 It would be useful to indicate what has changed from the inventory estimates that were made in 1994 Reassessment Document and what new information lead to these changes in estimates. Are there new emission factor or activities data, new analysis procedures, corrections to the original analysis, or other factors that contributed to the changes in estimates?

2.6 The very large estimates for CDD entering the environment from the use of PCPs in wood preservation (page 8-24) are not included in the summary section 2.0 (except as a list in the discussion on commercial products). The CDD entering the environment through the use of the pesticide 2,4-D does not appear in this section except in Table 2-3. The CDD emissions to the land from sewage sludge that is not incinerated is 207 g/year. These estimate dwarfs all other sources of CDD into the environment and should be highlighted more in the summary. What is the expected fate of the CDD from the product sources? What is the final disposition of the products and in particular the CDD in the products? It is not clear that the combustion sources to air are the dominant sources given the potential releases to air from these products.

Comments Relative to Chapter 3.0 "COMBUSTION SOURCES OF CDD/CDF: WASTE INCINERATION"

3.1 Classifications schemes based upon the known mechanisms of CDD/CDF formation and control is appropriate. However, the description of the current theories of CDD/CDF formation in combustion processes is weak and the relationship between the theories and the design and operation is not well established in the report. Significant progress has been made in the last several years on understanding the formation and control mechanisms of CDD/CDF from combustion processes. This understanding is critical to the development of classification systems and using data from one system as a simulation for another. A better section on the current understanding of the mechanisms and the impact of different combustion designs and air pollution control devices is necessary. With this background then all of the emissions data presented should be compared with the scientific underpinnings of the current understanding. Where does the data appear to be inconsistent with the current theories and where does it appear to be consistent? By addressing these types of issues the scientific quality assurance of the emissions data could be addressed, the limitations of the current fundamental understanding could be identified, and better categorization of equipment could be developed which reflects the current understanding.

3.2 The discussion of Modular incinerators needs some improvements. Starved air systems are not necessarily "newer types" or "easier and less expensive to operate than the excess-air type" In addition they usually do not use much auxiliary fuel by rather use near stoichiometric conditions in the secondary to achieve temperature. Auxiliary fuel is used only with poor fuel value waste. Finally particulate matter is low due to low primary chamber velocities not due to "high and uniform temperatures in the secondary."

3.3 The classification of RDF systems should include a separate category of pelletized and process engineered fuels. Most RDF systems use fluff RDF with spreader stokers and not pelletized fuels.

3.4 Cofired systems usually refers to cofiring RDF with other fuels such as coal not cofiring with normal MSW.

3.5 The point between cold side and hot side ESP is established at 230°C even though the formation window is stated to be 150-350*C. Why is 230°C adopted and what does it imply about the emissions inventory of lower temperature devices?

3.6 Dry scrubbers can impact dioxin formation through the addition of a quick quench through the dioxin formation window.

3.7 Wet scrubbers are not always two stage for HCl and SO2.

3.8 The classification scheme should also include the impact of furnace size. Larger furnaces are generally hotter and have more temporally uniform conditions while smaller units are generally colder and more variable.

3.9 The use of other system emission factor data for MSW combustion systems generally underestimates the emissions. For example in Table 3-3: Use of DSI/CI/H-ESP is clearly low for DSI/H-ESP since it includes a 90% control CI

- # Use of MB/WW is low for MB/ref (See directly comparable data for DS/C-ESP of 6.1 vs 51.1)
- # Use of RDF Ded/DSI/C-ESP is clearly low for H-ESP data (why not use H-ESP data)
- # Use of very low data for MOD/SA-DSI/FF for others is likely underestimate
- # Use of MB/WW for Fluidized beds is likely underestimated due to impacts of entrained PM

3.10. Some technologies are assumed to have no impact such as DS and DSI; why have separate classifications for these technologies? Is there convincing data that indicates that these systems have no impact. In addition EPA ORD data suggest that dry sorbent injection can have a significant impact on CDD/CDF emissions.

3.11 An alternative approach is to establish control efficiencies and formation efficiencies of air pollution control devices and then apply these to the base emissions from the furnace. The control/formation efficiencies could be established across other types of combustion furnaces as well as within the furnace type. Has this approach been considered? Why was it rejected?

3.12 The estimate should include the trends established by OAQPS due to regulatory impact analysis for MSW combustion in the Chapter 2 summary. While MWCs appear as the most important dioxin source in 1995 they should be a much less important source in 1998.

3.13. Typo on page 3-14 "MWI" should be HWI
Typo on page 3-18 "sophisticated"

3.14 In the description on page 3-18 of post combustion control, it should be clarified that the use of particulate matter control at the wrong temperature (between 150-350°C) can result in higher dioxin emissions.

3.15 The Hazardous waste incinerator MACT database has been updated since 1996. It now contains 24 data sets. Is there some reason why this full data set was not used instead of just 17 points? The Office of Solid Waste estimates for emissions from hazardous waste incinerators is 22 g/yr for some of the reasons discussed on page 3-21. It would be useful to the reader to have this actual number to compare with the ORD assessment of 5g TEQ/yr. The OSW approach is not well presented in this section. In particular the OSW approach did classify by size and air pollution control device temperature when they were known . Selected facilities within a similar range of APCD temperatures were randomly selected and directly substituted its TEQ and congener distribution for the missing data. When feedrates were known they were used directly using a randomly selected facility of similar size. Completely random imputing was only undertaken for those facilities where flow rates and APCD temperatures were not known. A better comparison and contrast with the OSW method as was done for medical waste incinerators is recommended.

3.16 The hazardous waste incinerator emissions estimate procedures appears to be more quantitative than the Municipal solid waste estimate. No subcategorization was made with the hazardous waste incinerators. Has any attempt to classify the emissions factors been undertaken? The technology and air pollution control description could be used as the basis for this classification.

3.17 Industrial Boilers and Industrial Furnaces burning hazardous waste. This section requires significant revision. The BIF rules do not restrict burning to 5% of the primary fuels and are not merely directed at liquid fuels. Cement kilns, light weight aggregate kilns and other furnaces are included in this rule. If this category is restricted to industrial boilers burning hazardous waste it is still not correct. Many industrial boilers burning hazardous waste are dedicated units burning 100% hazardous waste.

ORD should contact the Office of Solid Waste for better information on this category. It is not clear if the 0.6 billion kg of hazardous waste attributed to boilers/furnaces in the 1996 Federal Register notice are boilers only or also include other industrial furnaces. There is some concern that there is double counting of the hazardous waste burned in cement kilns.

This is a case where the range of 10 appears to be too small. With only two boilers tested with an unknown waste type and boiler design it is not at all clear that they can represent the mean emission factor. A factor of 100 would seem more appropriate. Again better justification of the uncertainty range determination appears to be in order.

3.18 *Medical Waste Incinerators*. The section on medical waste incinerators is good. The comparisons and contrasts with alternative recommended efforts is well done and the alternative selection assumptions are well documented. The OAQPS procedures for estimating the emissions from medical waste incinerators appears to be particularly weak and the ORD approach appears to be much stronger. The inverse correlation between stack particulate matter and residence time is purely conjectural and does not have any basis is fact or fundamentals. Particulate emissions are likely controlled by entrainment velocities in the primary chamber which is unrelated to the secondary chamber residence time. Again with confidence low in both activity and emission factors a range of 10 in estimates is not well supported. Finally a prediction of the impact of the newly promulgated emissions standards is recommended.

3.19 Table 3-16 is missing notes f/ to n/.

3.20 Crematoria. The CARB measurement of 0.5g/body is NOT "very similar" to the German measurement of 4.9 g/body.

3.21 *Sewage Sludge*. The confidence level of the emissions data was assumed to be medium even though only 13 facilities out of 199 were tested and the data for the thirteen units varied from 90 to 3400 ng/kg. A range of annual emissions estimates of only five is difficult to justify given the range in 38 in emission factors.

3.22 *Tire Combustion*. As it noted in the report the one test unit is a large and highly controlled test unit that is unlikely to be representative of the vast majority of tire combustion systems. The low confidence rating is clearly justified but a factor of greater than 10 is appropriate and the range should reflect the low bias of the data. Why is the UK data not useable as another source of emissions factor data?

3.23 *Biogas combustion*. Generally flares have been found to effectively destroy trace organics in the gases as long as the flare is stable and above a minimum heating values (See EPA OAQPS studies on flare performance). The emissions measurements within the flare by Schreiner may actually be indicative of the CDD/CDF levels of the biogas and not the flare emissions.

Comments On "4. COMBUSTION SOURCES OF CDD/CDF:POWER/ENERGY GENERATION"

4.1 *Motor Vehicle*. The use of European data for emissions factors is appropriate whenever the U.S. Database is weak. The characterization of the data as having low confidence due to inherent differences in fuels and emissions control technologies is also appropriate. One additional consideration area relative to unleaded gasoline data and diesel engine data sets is the levels of ambient chlorine. Ambient levels of chlorine in the combustion air can potentially be a major source of chlorine and are known to be much higher near the ocean or industrial sources. This might be a cause for the higher levels of CDD/CDF reported in the Norway and Baltimore tunnel tests. It is important in future discussions and testing programs to consider this source of chlorine on CDD/CDF formation. Nonetheless, the use of the Gertler Baltimore data appears to be appropriate at this time.

4.2 *Residential Wood Combustion*. The emissions factors were derived from data from Vikelsoe which was widely variant for the 24 different fuel/stove type/operating conditions. How does the ariation compare with the low confidence variation assumed to be 10? A larger range would appear to be justified by the range of emission factors.

4.3 *Industrial Wood Combustion*. Since the salt water soaked wood firing test indicated higher CDD/CDF emissions, is there any estimate of the amount of salt water soaked wood fired in the U.S.? Again the levels of chlorine in the combustion air may also become important for lower levels of CDD/CDF emissions.

4.5 *Utility and Industrial Oil Combustion*. This section was found to be lacking compared to completeness of discussion for other sources. For consistency of treatment, the underlying data used in the OAQPS (1995c) assessment of oil combustion should be discussed. Are these data from residual fuel oil only? What was the level of sulfur and chlorine? Given the impact of sulfur on CDD/CDF formation, a better discussion of the data relative to low sulfur and high sulfur fuels would be appropriate. Also a better description of the presence and type of particulate control devices is necessary in order to evaluate whether the particulate matter control device is influencing emissions factors. See also the discussion below concerning evaluation of high emission sources.

4.6 *Coal Combustion in Industrial and Utility Applications*. While the data from cold side ESP's is well represented by the EPRI and DOE data sets. It is important for this assessment to determine if these data are representative of the national inventory of Coal fired units. Has any surveys been conducted to determine the types of industrial and utility boilers that are in operation? Particular

attention should be placed on examining those boiler types (e.g., smaller with less combustion efficiency), fuel types (e.g., low sulfur, high Cl) and air pollution control parameters (hot side ESPs) that could potentially have higher emissions factors. Given the large size of the individual units, a few sources with high emissions factors could dominate the national emissions. The report should address the representativeness of the EPRI and DOE data and evaluate the potential for significant emitters.

Comments on Chapter 5. "COMBUSTION SOURCES OF CDD/CDF: OTHER HIGH TEMPERATURE SOURCES"

5.1 *Light Weight Aggregate Kilns.* Why are LWAKs not included? The Office of Solid Waste has estimated that LWAKs burning hazardous waste generated approximately 3.1 g TEQ/yr in 1995 which would place LWAKs in the top 20 air emission sources.

5.2 *Cement Kilns burning Hazardous waste*. There are broader array of introduction techniques for hazardous waste into cement kilns including midpoint injection than is discussed in this chapter.

5.3 The current EPA Office of Solid Waste Data base for cement kilns burning hazardous waste includes 31 tests sets (as compared to 12 in the ORD analysis). These newer tests should be used in the dioxin inventory analysis by considering the impacts of design/operation changes that have taken place since 1995 (e.g., lower ESP temperatures)were factored into the analysis.

5.4 A discussion of the differences in the ORD estimates and the OSW estimates for cement kilns burning hazardous waste should be undertaken. OSW estimated in 1995/6 that 57 g TEQ/yr from Cement Kilns burning hazardous waste while the ORD estimated 153 g. Some discussion of the different estimates from the same agency is important.

5.5 *Petroleum Refining Catalyst Regeneration Unit*s. The California Air Resources Board recently undertook a study of CDD/CDF emissions from Petroleum Refinery CRUs. The ARB should be contacted concerning the results of these emission measurements.

5.6 *Kraft Black Liquor Recovery Boilers*. Are there any survey data on the types of air pollution control used and in particular on the temperature of the particulate control devices? How was it determined that the NCASI tests were representative? Are there any configurations that might be expected to have much higher emissions factors?

Comments Relative to Chapter 6 "COMBUSTION SOURCES OF CDD/CDF: MINIMALLY CONTROLLED AND UNCONTROLLED COMBUSTION SOURCES"

6.1 *Combustion of Landfill Gas*. Are there any data on the levels of CDD/CDF in untreated landfill gas? Tests of open flares for trace levels of byproducts are particularly difficult given the dilution that occurs from ambient air entrainment. Some further discussion on how the California ARB test was conducted and the reliability of the measurements is recommended. OAQPS evaluated destruction efficiencies of trace species in flares and these data could potentially be used to estimate emissions from known levels of CDD in the landfill gas.

6.2 *Accidental Structural Fires.* The emissions data for structural fires appears to be sufficient to assess a rough order of magnitude estimate of annual emissions in a manner similar to that described by Carroll and Thomas and Spiro)

6.3 *Forest* Fires. It is not clear that the estimating procedures used for forest fires is sufficient to allow even a low confidence estimate to be made. The emission factor was selected from the "woodstove" analogy over two alternatives. The statement "This value appears more reasonable than the factors suggested by the soot and CO approaches" needs to be further clarified. This lower emission factor should not be selected just on the basis that it is lower. While it is important to quantify all sources as much as possible it is not clear that the basis used is strong enough to justify the estimate better than within an order of magnitude. At least the factor of 10 range does not appear to be sufficient to reflect the true uncertainty in this estimate.

Comments Relative to Chapter 7 "METAL SMELTING AND REFINING SOURCES OF CDD/CDF"

7.1 The estimate for secondary aluminum smelters should be further refined. Currently the approach involves the development of a single arithmetic average for the four facilities tested to date. It appears that a further categorization of the industry along the lines of facility design and operation profiles and air pollution control device type is possible. In particular, it appears possible to better project the impacts of air pollution control device efficiency on the performance.

7.2 It is worth more discussion and analysis on the scrap aluminum used in other segments of the aluminum industry. Over 2 million tons are consumed by other sectors and only 1.3 million by the secondary aluminum smelters. At least an order of magnitude analysis would be reasonable for this additional large volume of material.

7.3 The data on secondary copper smelters/refiners are surprisingly sparse given the potential importance of this source. The data consist of only one set of tests measured over a decade ago. It is not clear whether these data are in anyway reflective of the types of facilities used today. More definition of the 24 operating U. S. copper smelters should be developed. The classification of this assessment as having a low confidence rating and therefore a factor of ten uncertainty appears to be misleading given the very weak nature of the emissions data. In addition more that twice as much copper based scrap is consumed by other segments of the copper industry such as brass mills and wire-rod mills. Some attempt to roughly estimate these emissions must also be undertaken.

7.4 Relative to emissions factors derived for the secondary lead smelters, some attempt to examine the system removal efficiency demonstrated in these test against others data from other sources should be undertaken. Are the removal efficiencies consistent with those achieved by other systems where the performance data base is larger?

Comments Relative to Chapter 8 "CHEMICAL MANUFACTURING AND PROCESSING SOURCES"

8.1 While the activity and emission factor data do appear to be well established thus justifying the high confidence rating, the data on the deposition of the sludge was not rated. Are these percentage data also well established with high confidence?

8.2 The reference to section 4.1 (page 8-13 last paragraph) for details of the TSCA regulations is not correct.

8.3 Comments should be made in section 8.3.3 on the reliability of the TRI reported data for PCB emissions assessments.

8.4 *PVC Manufacturing*. No estimate is provided in the summary in section 2 for PVC manufacturing. It is incumbent on EPA to at least provide a rough order of magnitude estimate for this controversial source or at minimum address the issues in the summary section. The lack of closure on this subject appears to be out of balance with other sources with similar levels of uncertainties. EPA should use the same criteria used for every other source and make its best estimate of the emissions levels from this source given the currently available data.

8.5 For several of the sources (e.g.,Chlorobenzene and chlorinated aliphatic chlorine compound manufacturing,) it is indicated that OSW has promulgated wastewater effluent limitations that do not specifically address CDD but are expected to reduce their release. This statement needs to

be further clarified. What technologies are used and how are they expected to impact emissions?

8.6 The basis for the chloronil CDD concentration level used in the estimate for Dioxazine Dyes in 1995 (i.e., 10 g TEQ/kg) is not clear. Is this one-half of the SNUR level of 20 g/kg? Why is this level chosen instead of 20 g/kg?

8.7 The very large estimates for CDD entering the environment from the use of PCPs in wood preservation (page 8-24) are not included in the summary section 2.0 (except as a list in the discussion on commercial products). This estimate dwarfs all other sources of CDD into the environment and should be highlighted more in the summary. What is the expected fate of the CDD in the PCP used in wood preservation? What is the final disposition? Given the

significance of this source a more thorough discussion of the ultimate fate of this material would appear to be necessary.

8.8 The estimates for CDD entering the environment through the use of the pesticide 2,4-D is not included in the summary in Section 2 except in the summary table. What is the ultimate fate of the CDD in the environment from this source? How much enters the air?

8.9 The estimates for CDD in sewage sludge placed on the land is significant. Is there any estimate of the amount that enters the air through the land filling process?

Comments Relative to Chapter 9 " BIOLOGICAL SOURCES OF CDD/CDF"

9.1 Some extrapolation of the potential (order of magnitude) impacts of these biological sources might be worthwhile in order to determine if they are significant contributors.

Comments Relative to Chapter 10 " PHOTOCHEMICAL SOURCES OF CDD/CDF"

No comments on this literature review. Not my area of expertise

Comments Relative to Chapter 11 " SOURCES OF DIOXIN LIKE PCBs"

11.1 Rerelease of reservoir sources of dioxin like PCB's is identified as a major source of emissions. How was it concluded that this is significantly larger than release from current use and disposal of PCB containing materials? Is this defendable in light of the next conclusion that there is insufficient data to determine the extent of newly formed sources? What does this say about the rerelease of CDD from reservoir sources?

11.2 The emissions estimates for PCBs from the thermal treatment of PCB materials should be further developed. The estimate in this chapter appear to be unrealistically high and not well established. Why is the assumption made that the PCB is treated only in high-efficiency boilers and 99.99% assumed? TSCA incinerators must demonstrate 99.9999% destruction efficiency through trial burn testing or two orders of magnitude higher destruction efficiency than is used in this estimate. The EPA must have activity data for all TSCA licensed facilities that would allow a further refinement in the amount of material treated at different types of facilities and trial burn data could be used to define the levels of destruction efficiency and the emissions levels. In addition the emission factors determined by testing are likely to lower than the standard. The total PCBs is used instead of the dioxin like congeners. It is unlikely that all the PCB would be converted to dioxin like PCB so a better estimate would be that the treatment does not effect the congener distribution but rather all congeners are destroyed with the same efficiency. Therefore the emissions would be 84:1 million less than the emission estimated given(i.e., the ratio of TEQ

to total PCB in Table 11-3). TSCA trial burns require the quantification of congeners specific information that would be useful to estimate dioxin like species.

11.3 Has EPRI been contacted relative to their assessment of the current use of PCB containing transformers in the utility sector and the accident incident assessments?

11.4 It is not clear that the annual air emissions estimates of 2.7 kg and 0 kg derived from the TRI data are accurate representation of the actual emissions. These estimates should be

treated as order of magnitude estimates only and treated in the same manner as those for CDD rough estimates.

11.5 During the discussion of the sewage sludge estimates the reader should be referred back to the estimates for CDD in sewage sludge (chapter 8). Chapter 8 should also refer forward to the PCB dioxin like TEQ in sewage sludge. The summary in section 2 should add these two sources together to indicated the relative importance of the sewage sludge source.

11.6 The emissions estimates for tire combustion should be further qualified by the fact that the emissions source tested by CARB is very different than the majority of tire combustion processes.

Valerie Thomas

Dioxin Inventory Peer Review

Pre-Meeting Comments

1. Is the general method used to estimate dioxin emissions reasonable ?

The general method is reasonable. However, the exclusion of non-US data is unsupported, and results in the exclusion of what appear to be major sources.

2. Evaluation of emission estimates by source.

Municipal Waste combustors

p. 3-1. Categorization of waste incinerators. The approach presented here is to divide incinerators by combustor type, fuel type, APCD type. What is the evidence that emission factors are statistically different between categories? Would we do just as well to lump them together? The evidence for assuming that incinerators in the same category have the same emission factor has not been presented. For those cases in which more than one facility in a category has been tested, what was the range in emission factors?

p. 3-11. and Tables 3-1 through 3-5. The method for establishing the factor of five uncertainty in emissions is unsupported. The emissions should not be "assumed to ... varies by a factor of five.... "(p. 3-11) There is more data on incinerators than any other source. The uncertainty range should be based on the actual data.

Hazardous Waste Combustors

p. 3-19. "the emission factor is assigned a medium confidence rating"; p. 3-21 "emissions is assumed to vary by a factor of five" Again, the confidence rating should be based on the range of the measured values and the fraction of facilities tested.

p. 3-21. What emission factor did EPA/OSW get with its procedure?

Crematoria

p. 3-37. Why is the crematoria emission factor given a low confidence rating "because it represents testing at only one US facility"? Are US crematoria different? Nevertheless, the factor of 10 uncertainty range seems reasonable.

Secondary Copper Smelters

p. 7-6. Are the high emissions from this source plausible?

3. Are the overall observations and findings presented in Chapter Two reasonably developed from the evidence?

On the absence of large natural sources (p. 2-11): Now that dioxin has been discovered in ball clay deposits, is it still correct to say that large natural sources of dioxin have not been identified?

(p. 2-10. It is Table 2-5, not 2-6, that contains rough estimates of excluded emissions. And for Figure 2-1, in my copy, the medium confidence and the high confidence indications are identical: both look black.)

4. Should any additional sources be added to the National Inventory?

Landfill fires (p. 6-10), backyard trash burning (p.6-15), and sinter production (p. 7-12) should be included in the emissions inventory. The estimates indicates that each of these is one of the largest sources of dioxin.

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Dioxin Inventory Peer Review Meeting

Pre-meeting Comments

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It is my pleasure to review the draft of the Inventory of Sources of Dioxin in the United States and the accompany database. The document and database include a lot of information on dioxin emission estimates and a detailed description of the methods used to obtain these estimates. Due to the time constraints, it is impossible to perform a thorough review on the document and the calculations. Therefore, the comments provided in the following sections are preliminary.

I. General Method Used to Estimate Dioxin Emissions

Overall, the document summarizes the observations and key findings on a wide variety of source categories and provides a national approximation of a dioxin inventory. The criteria used to include/exclude emissions test data and the method of judging uncertainty and assigning confidence ratings are reasonable. The use of a confidence rating to indicate the uncertainties is a good practice. However, the determination of the confidence rating for emission factors and activity level is ambiguous and seem somewhat arbitrary, especially, for the low confidence rating

I like the emission factor approach. This approach standardizes the emission estimation procedure. It is reasonable, feasible, and easy to follow. In addition, using the emission factor approach will facilitate the "bottom up" emission inventory development. In some cases, state agencies have or can collect site-specific activity data but could not compile an emission inventory due to a lack of information on emission factors. With the emission factors in this document, an emission inventory could be developed at a state level. The method used by EPA to derive emission factors from the available test data is reasonable.

As an emission inventory, it is necessary to clearly identify the pollutants covered by the inventory. A statement is made on page 2-1, "this report summarized information on the release of CDD/CDFs and dioxin-like PCBs to the environment from suspected source categories". However, it doesn't specify which CDD/CDFs included in the inventory. Looking through the document and database, I found the inventory covered the 17 CDD/CDF congeners that have dioxin-like toxicity, 10 congener groups (from tetra to octa), total CDD/CDF (only included the 10 congener), and total TEQ. It would be better to have a list of all pollutants in Chapter 2.

Care should be taken on the consistency of the nomenclature. The presentation of equations needs to be polished.

II. Source Specific Comments

The headings in this section are the same as those used in the document. These headings are not continuous because only the sections with comments are presented.

3.1. Municipal Solid Waste Incineration

As indicated in the document, EPA has more intensively and extensively evaluated MSWI than other source categories. The description of the technology is complete. Since more emission data are available to this category, subdividing source categories and deriving emission factors, are reasonable. The emission estimates are sound.

In Equation 3-1, H = total hours in a year (8,760 hr/yr). It is a constant and might be better to expressed as a value not a variable.

3.2. Hazardous Waste Incineration

The description of the technology is complete. The reasons for not subdividing the dedicated hazardous waste incinerators are clearly stated.

To derive the overall average congener specific emission factor, the Equation 3-4 should be as the following:

$$EF_{argHWI} = \frac{EF_{hwi_1} + EF_{hwi_2} + EF_{hwi_3} + \ldots + EF_{hwi_{17}}}{17}$$

or

$$EF_{avgHWI} = \frac{\sum_{j=1}^{17} EF_{hwi_j}}{17}$$

Where:

EF_{avgHWI} = Average emission factor of 17 tested HWIs, ng/kg

3.3. Medical Waste Incineration

According to the description in the last paragraph on page 3-27, the annual hours of operation were determined by assuming a capacity factor (defined as the fraction of time that a unit operates over the year). However, the product of annual medical waste charging hours and capacity factor is shown in Equation 3-6. It should be either a product of total hours in the year (8760 hr/yr) and capacity factor, or just the annual hours of operation.

The nomenclature in the whole document should be consistent. The comment on Equation 3-1 could be used in Equation 3-6. The symbol used for capacity factor should be the same as the one used in Equation 3-1.

The document mentions both the EPA/OAQPS approach and the AHA approach, but didn't describe the method used to estimate the activity level in AHA approach. The adoption of the AHA subcategorization scheme to the EPA/ORD approach is reasonable. The document also points out the differences between the EPA/ORD and AHA approaches are primarily due to the use of different sets of emission tests to derive their emission factors. Is it possible to combine the available AHA emission test data to the ORD approach?

The calculation of the annual TEQ air emission of all MWIs (Equation 3-7) should be written as follows to keep the nomenclature consistent and to avoid the double use of the summation signs.

$$E_{MWI} = E_{mwi_1} + E_{mwi_2} + \ldots + E_{mwi_{2375}}$$

or

$$E_{MWI} = \sum_{j=1}^{2375} E_{mwi_{ji}}$$

Where:

E_{MWI} = Nationwide MWI TEQ emissions (g/yr)

3.4. Crematoria

The document mentions three emission tests conducted at one crematorium in the United States yield a emission factor very similar to the emission factors reported by Bremmer et al. (1994). However, the emission factor in Bremmer's measurement is 4.9 µg TEQ per body which is almost 10 times of the emission factor yielded in the United States, 0.5 µg TEQ per body. Use of the words "very similar" seems inappropriate.

3.5. Sewage Sludge Incineration

There are three principal combustion technologies in sewage sludge incineration, but no reasons are given to explain why the source category was not subdivided accordingly. As observed by EPA, a wide variability exists in the emission factors for the test facilities. Does this variability correlate to the different combustion technologies?

3.8. Biogas Combustion

Page 3-43, last line, "30-trillion" should be "30-billion".

4.1. Motor Vehicle Fuel Combustion

The emission factors for unleaded gasoline vehicles were derived from three catalyst-equipped cars tested in Europe at speeds of 63 km/hr and 64 km/hr. Extrapolating these emission factors to a huge fleet of unleaded gasoline vehicles in the United States seems not defensible. The fuels, emission control technology, and driving conditions may differ from those in the testing cases significantly. Although a low confidence rating was assigned to the emission factors, it may be better to classify this category to the sources for which only rough estimates could be made (such as those listed in Table 2-5).

Use of the tunnel study conducted in Baltimore to develop emission factors for diesel-fueled trucks is quite reasonable. However, these emission factors represent emissions from heavy-duty diesel trucks. It is unclear in the document that "diesel-fueled trucks" refer to all diesel-fueled trucks or only heavy-duty diesel trucks. Are there any considerations of diesel vehicles other than trucks?

4.2. Wood Combustion

For residential wood combustion, the TEQ emission factor is derived from studies by Schatowitz et al, and Vickelsoe et al. Schatowitz et al. did not report the congener/congener group analytical results. Vickelsoe et al. did not measure congener levels and assumed the same congener distribution as that found for municipal waste incinerators. Therefore, emission factors are not developed for the congeners by EPA.

However, in the industrial wood combustion sector, results of the EPA study are excluded because congener-specific measurements for most 2,3,7,8-substituted congener were not made. It seems the data selection criteria are not consistent. Excluding the EPA study might lead to underestimates of emissions from this category. Are there any ideas about the quantity of salt-laden wood consumption? If the quantity is not negligible, EPA may need to treat salt-laden wood combustion as a subcategory.

4.4. Coal Combustion

Descriptions of the technology used for utilities and industrial boilers are not presented.

It is necessary to explain why the utilities and industrial boiler category is not subdivided on a basis of coal type.

5.1. Cement Kilns

Same comments on Equation 5-2 as on Equation 3-4: summation sign and plus sign are duplicated.

5.2. Asphalt Mixing Plants

The potential emissions is estimated for a preliminary order of the magnitude for this source category because emission factors are reported from measurements in Netherlands and Germany. It appears a right decision. However, comparing with the criteria for assigning confidence ratings (Table 2-1), the emission factor seems to fall in the low confidence rating.

5.4. Cigarette Smoking

The definitions of mainstream smoke and sidestream smoke are not described. In the second method, what flow rates for the mainstream and sidestream are used, respectively? This information is useful for understanding why two methods are needed.

5.5. Carbon Reactivation Furnaces

What supports the assumption of 50% mass of GAC for industrial uses and another 50% for municipal uses? Additional information is needed for validation.

6.2. Accident Fires

From the data provided in the document, structure fires seem to have a significant contribution to the dioxin emissions. The approach used by Carroll is interesting. If EPA can have more study on this subcategory and provide an order of magnitude for emissions, it will be helpful in the dioxin reassessment.

7.2. Secondary Nonferrous Metal Smelting

EPA indicates the PVC separator in batteries is the source of CDD/CDFs at the secondary lead smelters. The percentage of scrap batteries which contained PVC separators and were processed at lead smelters was about 1% in 1991 and less than 0.1% in 1994. The decreasing trend of the CDD/CDF source need to be considered in the TEQ estimation.

7.6. Drum and Barrel Reclamation Furnaces

The emission factors for this category are per drum based. The activity data are also expressed as drums. Discussion of the drum weight seems irrelevant to the emission estimation.

8.3. Manufacture of Halogenated Organic Chemicals

Discussions in Section 8.3.3. Chlorobiphenyls are on the use of PCBs and do not fit the "manufacture" heading. EPA may consider to change the heading to "Manufacture and Process of Halogenated Organic Chemicals".

9. Biological Sources of CDD/CDF and 10. Photochemical Sources of CDD/CDF

The document presented the evidence of CDD/CDF formation form these two source categories. However, the quantification seems to be a challenge.

III. Additional Sources

PCP treated wood is recognized as a reservoir source in the document. However, estimates are not made by EPA due to the lack of reliable measurements. It is noted that some information on utility poles in service is provided by the Environment Canada and the Federal/Provincial Task Force on Dioxins and Furans in a Draft of "Dioxins and Furans and Hexachlorobenzene Inventory" (April 1998). The reference indicates that the CDD/CDF releases to soil are the most significant, the atmospheric emissions are from

the poles treated before 1987 and only a small amount from the poles treated after 1987. Also some preliminary estimates are given in the reference.

IV. Other Comments

Nordic-TEQ is mentioned several times in the document. It would be helpful to have a brief description of the conversion of Nordic-TEQ to TEQ.

Typo errors:

Page 1-4, first paragraph should be deleted.

Page 2-10, line 6, "Table 2-6" should be changed to "Table 2-5".

Page 3-23, line -2, "Figure 3-12 displays a schematic of a typical modular furnace using controlled-air" but the figure is missing.

Page 3-28, line -8, "Table 3-8" should be changed to "Table 3-9".

Page 3-33, line -6, "and one atmosphere" should be deleted because standard pressure is one atmosphere.

Chapter 3 equations The multiplication sign used is "*x*". It is better to use the symbol in the Equation Editor, " × ".

Page 3-68, Table 3-10, TEQ emission factors for uncontrolled MWIs up to 200 lb/hr is 1.53e-3. However, the same emission factor on Table 3-12 is 1.54e-4.

Figure 3-2 - 3-5, all descriptions are unclear, and the text font needs to be changed.

Page 4-11, line 13, "is based" should be deleted.

Page 4-44, It is hard to distinguish the different tests. Using different patterns will be better.

Page 5-6, line –2, "HWIs" should be changed to cement kilns.

Page 5-7, line 2, "Ef_{aveCK}" should be "EF_{aveCK}".

Page 5-8, line 2, "(12 out of 34 or 35" should be "12 out of 34 (or 35".

Page 5-21, line 16, "GAC reaction" should be "GAC reactivation".

Page 5-12, line –12, "one industrial GAC" should be "one GAC".

Dioxin Inventory Peer Review Meeting
Guidelines for Technical Review

Please address the following when conducting your peer review:

1. Is the general method used to estimate dioxin emission reasonable in terms of:

- **#** the criteria used to include/exclude emissions test data
- **#** the method of judging uncertainty and assigning confidence ratings
- **#** emission factor approach

2. To the extent possible, <u>for each source</u>, we recommend that the peer reviewers address the following questions:

- **#** Is the description of the technology complete and accurate?
- **#** Is the system of subdividing each source category reasonable for purposes of estimating dioxin emissions?
- **#** Is the derivation of average congener-specific and dioxin TEQ emission factors technically sound and defensible?
- **#** Are the activity estimates reasonable and well documented?
- **#** Are the confidence ratings assigned for the emission factor, activity level, and overall emission estimates reasonable?
- **#** Have the suggested alternative approaches been described clearly and appropriately evaluated?

3. Are the overall observations and findings presented in Chapter Two reasonably developed from the evidence?

4. Should any additional sources be added to the National Inventory?

- **#** For example, the sources listed in Table 2-5.
- **#** Are the order of magnitude estimates listed in Table 2-5 appropriate?

5. Please feel free to point out any additional issues that you feel need to be addressed during the peer review.

Dioxin Inventory Peer Review Meeting

Ramada Plaza Hotel Old Town
Alexandria, VA
June 3–4, 1998

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Environmental Protection Agency
National Center for Environmental Assessment

Dioxin Inventory Peer Review Meeting

Ramada Plaza Hotel Old Town
Alexandria, VA
June 3–4, 1998

Agenda

W E D N E S D A Y , J U N E 3 , 1 9 9 8

7:30AM **Registration/Check-In**

8:30AM **Welcome and Introductory Remarks** . . . . . *Valerie Thomas, Panel Chair*
Center for Energy and Environmental Studies,
Princeton University,
Princeton, NJ

8:45AM **Opening Remarks** . . . . . *William Farland*
Director,
National Center for Environmental Assessment (NCEA),
U.S. Environmental Protection Agency (U.S. EPA),
Washington, DC

9:00AM **Overview of Dioxin Inventory and Database** . . . . . *David Cleverly*
NCEA, U.S. EPA,
Washington, DC

9:30AM **Workshop Structure and Objectives** . . . . . *Valerie Thomas*

9:45AM **Charge to the Panel/ Highlights of Premeeting Comments** . . . . . *Valerie Thomas*

10:00AM BREAK

10:15AM **: Overview of Sources**

11:00AM **ombustion Sources of**

CDD/CDF—Waste Incineration
- # Municipal solid waste incineration
- # Hazardous waste incineration
- # Medical waste incineration

12:00PM LUNCH

W E D N E S D A Y , J U N E 3 , 1 9 9 8 (c o n t i n u e d)

1:00PM **Discussion of Chapter 3 (continued)**
Other incineration sources

1:30PM **Discussion of Chapter 4: Combustion Sources of CDD/CDF—Power/Energy Generation**

2:00PM **Discussion of Chapter 5: Combustion Sources of CDD/CDF—Other High Temperature Sources**

2:30PM B R E A K

2:45PM **Discussion of Chapter 6: Combustion Sources of CDD/CDF—Minimally Controlled and Uncontrolled Combustion Sources**

3:15PM **Observer Comments**

4:15PM **Day One Summary** . . . . . *Valerie Thomas*

5:00PM A D J O U R N

T H U R S D A Y , J U N E 4 , 1 9 9 8

8:30AM **General Announcements/Review of Day Two Objectives** . . . . . *Valerie Thomas*

8:45AM **Discussion of Chapter 7: Metal Smelting and Refining Sources of CDD/CDF**

9:15AM **Discussion of Chapter 8: Chemical Manufacturing and Processing Sources**

10:00AM **Discussion of Chapter 9: Biological Sources of CDD/CDF**

10:15AM B R E A K

10:30AM **Discussion of Chapter 10: Photochemical Sources of CDD/CDF**

10:45AM **Discussion of Chapter 11: Sources of Dioxin-like PCBs**

11:45AM L U N C H

1:00PM **Observer Comments**

2:00PM **Synthesis and Summary of Recommendations** . . . . . *Valerie Thomas*

3:00PM A D J O U R N