

Ms. Susan Brager Murphy
Attn.: Dioxin Inventory Review
Eastern Research Group, Inc.
110 Hartwell Ave.
Lexington, MA 02173-3134

Dear Ms. Murphy

I have reviewed, "The Inventory of Sources of Dioxin in the United States" (External Review Draft — EPA/600/P-98/002Aa) and "Database of Sources of Environmental Releases of Dioxin-like Compounds in the United States (External Review Draft — EPA/600/P-98/002Ab) on behalf of the Hearth Products Association (HPA). Written comments provided in this letter address the treatment of residential wood combustion (RWC) in the two documents. Mr. Michael Van Buren, Technical Director with the HPA, will also provide verbal comments during the June 3-4, 1998 peer-review meeting. Due to the time limitation for verbal comments, Mr. Van Buren will only summarize the key issues we discovered in the review. More detailed information and references are provided in this letter.

As acknowledged in Figures 2-1 and 2-2 of the Overview of Sources Section (Section 2) of the inventory document (EPA/600/P-98/002Aa), dioxin emissions were not directly measured from a single woodstove or fireplace among the 25 million estimated to be in use in the United States. The Figures 2-1 and 2-2 give the ratio of tested to total units as 0/25,000,000. In the database document (EPA/600/P-98/002Ab), the Residential Wood Combustion section (Section A.2.2.1) of Appendix A (Summary of Emission Test Data and Activity Levels) contains two sentences. It refers the reader to Section 4.2.1 of the inventory document for the derivation of the emission factor used in the national inventory and restates the same activity levels discussed in Section 4.2.1. The data presented in Section 4.2.1 do not support the emission factor of 2 ng TEQ/kg wood combusted that is presented in the text nor are they of the quality needed to calculate quantitative values for use in the national inventory shown in Tables 2-2 and 2-3 and in Figures 2-1, 2-2 and 2-3 of the inventory document.

The limitations of the data presented in Section 4.2.1 include:

- Only two studies provided direct measurement of CDD/CDFs in flue gas and these were from European stoves (Schatowitz et al. (1993) and Vikelsoe et al. (1993) as referenced in Section 4.2.1). Upon review of these two key references it was found that Schatowitz et al. tested only one stove that was considered a residential stove. It was tested twice with wood (once with the door closed and once with the door open). Vikelsoe et al. tested four Danish stoves. One was, based on its description, an unusual research stove and inappropriately included in the average. In summary, the dioxin (more correctly, TEQ)

emissions for all 25 million woodstoves and fireplaces in the United States were derived from one Swiss stove and four Danish stoves (one inappropriately included in the average) all using European wood.

- Both Schatowitz et al. and Vikelseo et al. used different sampling and analytical protocols. In addition, both used different TEF schemes. Schatowitz et al. used the NATO I-TEF scheme and Vikelseo et al. used the Nordic TEF scheme. TEQ values calculated by different TEF schemes for a given environmental sample can have as much as a fivefold difference (EPA/625/3-89/015). A cursory review of the dioxin literature found one article that presented TEQ values for milk samples calculated by both the Nordic and U.S. EPA TEF schemes (Startin, J.R., Rose, M., and Offen, C., 1989, *Chemosphere*, V. 19, pp. 985-988.). In that study, the TEQ values calculated by the Nordic TEF scheme differed by nearly a factor of two as compared to those calculated by the U.S. EPA TEF scheme. More significant, Vikelseo et al. did not measure congener levels in the RWC samples, and TEQ values were calculated assuming the same congener distribution in each congener group that was found in emissions from municipal solid waste (MSW) incineration. Because combustion conditions in a residential wood stove are dramatically different than in a MSW incinerator, because wood is composed almost exclusively of cellulose and lignin whereas MSW is composed of a “potpourri” of materials and because there is a paucity of chlorine in cordwood as compared to the chlorine content of MSW, this is a seriously flawed assumption. In summary, the results of the Schatowitz et al. and Vikelseo et al. studies are not comparable with each other nor with the values for other dioxin sources presented in the national inventory. More importantly, the TEQ results from the Vikelseo et al. study, which represent the larger of the two data sets, is unlikely to be representative of the “true” TEQ value due to assuming the congener distribution from RWC is the same as from MSW incineration. The sum of these issues could easily have an order or magnitude or more effect on the results.
- In Section 4.2.1 it is stated, “Based on the results reported by Shatowitz et al. (1993) and Vikelseo et al. (1993), 2 ng TEQ/kg appears to be a reasonable average emission factor for residential wood burning.” Also in Section 4.2.1, 0.77 ng TEQ/kg and 1.25 ng TEQ/kg are the two values listed for the one residential woodstove burning cordwood with the door open and closed, respectively, from the Schatowitz et al. study and 1.9 ng Nordic-TEQ/kg is the average value given for the results reported from the Vikelseo et al. study. Even if the results from the two studies were comparable, 2 ng TEQ/kg is not a reasonable average of the study results.
- Beyond the small effect of an arithmetic averaging error, the probability of the mean of results from testing five European stoves representing the true mean of a population of 25 million diverse U.S. residential wood burning units is small. Emissions from RWC have been shown to be highly variable. There are many hundreds of types or models of wood burning devices in use, many dozens of tree species are commonly used for fuel, draft characteristics vary from home to home (chimney conditions), household altitude is variable, there are variations in fuel wood seasoning and storage practices (wood moisture), and there are wide variations in home occupant operation of wood burning

devices (burn rate, burn duration, fuel sizing, damper setting, kindling approach, etc.). To provide some insight to the magnitude of variations that could be expected for dioxins and furans the reader is referred to EPA-600/2-90-001a. In that study a single stove was tested twelve times under six sets of conditions for extractable organic material (EOM), the 7-PAH and 16-PAH surrogates for polycyclic organic matter, and for benzene. The standard deviations of the results from the tests on the one stove represented 83%, 102%, 61% and 45% of the means for EOM, 7-PAH, 16-PAH and benzene, respectively. The magnitude of the variation in TEQ among the large number of parameters encountered in the real-world use of RWC devices must be very large. Statistically using five stoves to represent millions of devices is fundamentally in error.

- In addition to the Shatowitz et al. and Vikelsoe et al. studies that measured dioxin in the flue gas, the results of a number of other studies that measured dioxin and furan congeners in chimney soot and bottom ash are anecdotally discussed (with attendant tables) in Section 4.2.1. These studies are interesting but their discussion and associated data tables should be deleted from the section. They add nothing to the fundamental purpose of EPA/600/P-98/002Aa, i.e., to develop an inventory of sources of dioxin in the United States, and they tend to give the false impression that there is more relevant data than there is in fact. Emission factors cannot be calculated from their data and the congener makeup of soot and bottom ash, based on fundamental physics and chemistry, will be unlike that in flue emissions. The production of chlorinated dioxins and furans from combustion are though either to be formed from other chlorinated compounds (viz., the condensation of chlorophenols) or from the thermal synthesis from inorganic chloride and organic material. Their formation from either mechanism will produce a different relative mixture of congeners in flue emissions as compared to chimney soot or bottom ash. Chimney soot and bottom ash are enriched in high molecular weight polar organic compounds as well as inorganic compounds (e.g., chlorides) due to their high temperature environment and ash being composed to a large degree of non-combustible materials. Modern factory built chimneys are rated for 1000°F (538°C) and, while very variable, inside chimney temperatures for woodstoves are typically in the 400°F (204°C) range and for fireplaces in the 500°F (260°C) range. Chimney soot and bottom ash have a long exposure to this high temperature environment. In contrast, flue emissions are transitory and most particulate emissions are composed of lower molecular weight compounds that are in the vapor phase until the flue gases and vapors leave the chimney and mix and cool in ambient air causing them to condense into particles.
- The national residential wood combustion activity levels for 1987 and 1995 are given a “high” confidence rating in the text of Section 4.2.1 and in Figures 2-1 and 2-2 in the Overview of Sources section (Section 2) of EPA/600/P-98/002Aa. The “high” rating is

given since it is stated that the values are based on recent government survey data. This is correct for the 1987 data. However, the 1995 data is not based on a government survey but is an estimate (see footnotes to Table 10.3 in DOE/EIA-0384(96)). A “medium” confidence rating for the 1995 activity based on the rating scheme presented in Table 2-1 of EPA/600/P-98/002Aa is more appropriate.

- The 2 ng TEQ/kg wood emission factor was multiplied by the national activity level to produce a best estimate of national emissions and this best estimate was assumed to be a geometric mean. For a geometric mean to be relevant the distribution of TEQ emissions values for the population of wood burning devices has to be log normal. There is no evidence that the TEQ emissions values will have a log normal distribution. Further, since the wood emission factor was assigned a “low” confidence level, it was arbitrarily assumed that the calculated annual emissions would range by a factor of 10 from the low to the high end. There is no basis for this arbitrary assumption. In summary, even if the 2 ng TEQ/kg wood emission factor is a good measure of the central tendency of TEQ emission factors there is no basis for reporting the range of annual emission values shown in Section 4.2.1, in Tables 2-2 and 2-3 and in Figures 2-1 and 2-2 of EPA/600/P-98/002Aa.

In conclusion the RWC data do not support the 2 ng TEQ/kg wood combusted emission factor value nor do they support the quantitative calculation of national emissions for RWC. The reader of EPA/600/P-98/002Aa is left with the perception that the annual emissions for RWC can be quantitatively calculated with less than an order of magnitude uncertainty and that RWC is one of the major dioxin sources. The use of three significant figures in reporting the means and range of annual emissions in Section 4.2.1 and in Tables 2-2 and 2-3 and the use of logarithmic scales in Figures 2-1, 2-2 and 2.3 add to that perception. The most appropriate place for inclusion of RWC annual TEQ emission values, commensurate with the quality and quantity of the available data, would be Table 2-5 that shows one significant figure order of magnitude estimates.

Sincerely,

James E. Houck, Ph.D.

Vice President

OMNI Environmental Services, Inc.

Beaverton, Oregon