

Memorandum

To: Joe Mangino, Eastern Research Group

From: Jim Houck, OMNI Environmental Services, Inc.

Date: November 19, 1997

Re: Urban/Rural Allocation of Residential Wood Combustion Emissions -- Section 112(k)

The national emissions for pollutants from the "Residential Boilers: Wood/Wood Residue Combustion" category (more appropriately referred to as residential wood combustion (RWC)) are calculated in the 1990 Emissions Inventory of Forty Section 112(k) Pollutants external review draft document by multiplying an emission factor by an activity level. The activity level for RWC is the amount of wood burned. The United States Department of Energy (DOE) has published survey results for household energy consumption that are applicable to the 1990 base year.¹ The DOE data are for December 1989 through November 1990. The DOE data show that nationally there were 22.9 million households that burned wood. Of those 22.9 million, 16.8 million had an urban status and 6.1 million had a rural status. Less wood was burned per household for households with an urban status than with a rural status. The DOE report shows that on the average 0.9 cords were burned per household with an urban status and 2.3 cords per household with a rural status. The DOE report also shows that the total cords of wood burned nationally were 29.1 million with 15.1 million cords burned in the 16.8 million homes with the urban status and 14.0 million cords of wood burned in the 6.1 million homes with the rural status. The urban percentage of wood burned was $15.1/29.1 \times 100\% = 51.9\%$ and the rural percentage was $14.0/29.1 \times 100\% = 48.1\%$. Hence the urban to rural allocation of wood burning was 51.9% to 48.1%.

One reason that there was less wood on the average burned in households with an urban status is that there were relatively more fireplaces as compared to wood stoves used in urban areas than in rural areas. Besides the DOE survey there are three other surveys that have collected RWC data in the 1989-1990 time frame.²⁻⁴ From these surveys and the DOE survey a rough estimate of the ratio of the number of fireplaces to wood stoves can be calculated for urban and rural areas. The fireplace to wood stove ratio in urban areas and rural areas was approximately 2:1 and 0.75:1, respectively. On the average less than one cord of wood is typically burned in a fireplace annually. In fact, a recent study using data from the American Housing Survey, U.S. Department of Census, showed that only 53% of the single-family household that had a fireplace burned wood in it in 1993.⁵ Another reason that there is on the average more wood burned per household in rural areas is that a higher percentage of rural wood burners use wood as their primary source of heat than do urban wood burners. The DOE report shows that 1.5 million urban households out of a total of 16.8 million wood burning urban households (9%) used wood

as their main space heating fuel whereas 2.4 million rural households out of a total of 6.1 million rural households (39%) used wood as their main space heating fuel. In summary, even though there were more urban households with wood burning appliances than rural households, there was nearly a 50:50 split (51.8% to 48.2%) between the total wood burned nationally in urban versus rural areas due to the facts that there were relatively more fireplaces as compared to wood stoves in urban areas and a higher percentage of homes in rural areas used wood as their main space heating fuel as compared to urban areas. In general rural residents are perceived as more “serious wood burners” by the hearth product industry.

While the 51.8% to 48.2% urban to rural allocation of wood usage is well documented with credible survey data and the data are consistent with the Hearth Products Association staff’s perception, based on experience, of wood and appliance usage, the allocation of wood use still over predicts the urban percentage of hazardous air pollutants from RWC since emission factors (mass pollutant per mass of wood burned) for most hazardous air pollutants are lower from fireplaces than from wood stoves. For example, the emission factors for 7-PAH and 16-PAH for fireplaces are 0.007 lb/ton and 0.037 lb/ton as compared to 0.044 lb/ton and 0.718 lb/ton for wood stoves. (These data were used to calculate the weighted 7-PAH and 16-PAH emission factors used for the 112 (c)(6) emission inventory.⁶) Similarly, the emission factor for benzene from fireplaces is 0.68 lb/ton⁷⁻¹⁰ as compared to 1.94 lb/ton for conventional wood stoves used in the Section 112(k) external draft review document.¹¹ It is generally believed that fireplaces have lower hazardous air pollutant emission factors than wood stoves since combustion in fireplaces occurs in an oxygen rich environment often at high burn rates whereas combustion in wood stoves often occurs in oxygen starved conditions, which enhances the formation of products of incomplete combustion.

Since a single emission factor for each pollutant was used (multiplied by the amount of wood burned) to represent all emissions from RWC an adjustment to the wood usage allocation is necessary to provide an accurate allocation between urban and rural emission factors of hazardous air pollutants due to the different relative percentage of fireplaces and wood stoves each with different emission factors. A reasonable approach would be to use the ratio of benzene emission factors for fireplaces to wood stoves as a surrogate for all pollutants except 7-PAH, 16-PAH, EOM and TCDD TEQ. There are both fireplace and wood stove data for benzene and benzene is a single simple compound which may be more or less representative of the emission factor ratios of other single simple compounds. 7-PAH and 16-PAH are mixtures of complex organic molecules and they have both fireplace and wood stove data provided in the Section 112(c) document hence the ratio of emission factors between fireplaces to wood stoves can be calculated directly for them. EOM and TCDD TEQ are surrogates for mixtures of large organic molecules and the 16-PAH value would be the best measure for the ratio of their emission factors for fireplaces to wood stoves. (16-PAH represents simply more compounds than 7-PAH and should provide a better average value for that reason.)

Using simple algebra, the ratio of emission factors for fireplaces to wood stoves and the

urban versus rural allocation of wood burned in 1990, the following urban versus rural allocations are suggested. The allocations are clearly approximate but are based on logic and the best data available.

| <u>POLLUTANT</u> | <u>URBAN/RURAL ALLOCATION (%)</u> |
|---------------------|-----------------------------------|
| 16-PAH | 32.1/67.9 |
| 2,3,7,8 TCDD TEQ | 32.1/67.9 |
| 7-PAH | 35.7/64.3 |
| acetaldehyde | 40.9/59.1 |
| acrolein | 40.9/59.1 |
| benzene | 40.9/59.1 |
| cadmium compounds | 40.9/59.1 |
| EOM | 32.1/67.9 |
| manganese compounds | 40.9/59.1 |
| nickel compounds | 40.9/59.1 |

References and Footnotes

1. U.S. Department of Energy, Energy Information Administration, 1993, Household Energy Consumption and Expenditures 1990, DOE/EIA-0321(90).
2. Simmons Market Research Bureau, Inc., 1990, The 1990 Study of Media and Markets.
3. Mediamark Research Inc., 1989, Medimark Research, Household & Personal Appliances, Etc. Report.
4. U.S. Consumer Product Safety Commission, 1989, Room Heating Equipment Exposure Survey, Final Report, OMB control no. 3041-0083.
5. Kochera, A., 1997, Residential Use of Fireplaces, Housing Economics, March issue, pp.10-11.
6. Johnson, J., Eastern Research Group, Inc., January 15, 1997, Personal Communication

(data fax).

7. Johnson, J., Eastern Research Group, Inc., May 19, 1997, Personal Communication (data fax).
8. Shelton, J. and Gay, L.W., 1987, Colorado Fireplace Report, report prepared by Shelton Research, Inc. for Colorado Air Pollution Control Division, Denver ,CO.
9. Rudling, L., Bengt, A., and Lofroth, G., 1981, Chemical and Biological Characterization of Emissions from Combustion of Wood and Wood-Chips in Small Furnaces and Stoves, pp. 34-53 in proceedings of 1981 International Conference on Residential Solid Fuels Environmental Impacts and Solutions, Portland, OR, published by Oregon Graduate Center, Beaverton ,OR, 1982.
10. State of California Air Resources Board, 1980, Emissions from Residential Fireplaces, report no. C-80-027, (Appendix D, BAAQMD Test Results).
11. For most pollutants listed for RWC in the Section 112(k) external review draft document emission factors for wood stoves were used to represent the emission factor for fireplaces. For many of the pollutants there appear to be no good data bases available for fireplaces. Credible benzene emission factor data for fireplaces were provided to Eastern Research Group in May 1997 (see reference 7) but were not included in the calculation presented in the Section 112(k) external draft review document.