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**Summary of Stakeholder Comments on the Residential Wood Emissions Inventory  
Technical Support Document**

Prepared, July 10, 2006

*Stakeholder comments have been responded to in italics. Note comments not originally included in this document are added at the end.*

The Residential Wood Emissions Inventory Technical Support Document was emailed to the MANE-VU Technical Support Committee Emissions Inventory Work Group on June 16<sup>th</sup> and the replies were due by July 14<sup>th</sup>. Seven stakeholders commented on the template and their comments are summarized here. Comments were received from the following groups: the Wisconsin Department of Natural Resources Bureau of Air Management via Orlando Cabrera-Rivera, the Vermont Department of Environmental Conservation-Air Pollution Control Division via Jeff Merrell (with attachment), the Massachusetts Department of Environmental Protection via Ken Santal, the New Jersey Department of the Environment via Judy Rand, the Maryland Department of the Environment via Roger Thunell, the Pennsylvania Department of Environmental Protection Air Quality Bureau via Karen Gee, and the New Hampshire Department of Environmental Services via David Healy.

**General Comments**

Healy noted that nowhere in the document is the inventory year mentioned. Healy thinks that “2002 Base” or something similar should be added to the text and table titles to make it obvious that it is a 2002 inventory.

*Emission Inventory table titles in Technical Memo 2 have been modified to include “2002 Base Year”*

Healy’s second comment is in regards to the big picture: What is the ultimate purpose of this inventory? I thought that the MANE-VU modeling inventory was a done deal at this point.

Lastly, Healy noted that the OMNI estimates are more in line with New Hampshire 1999 residential wood estimates, which were done using AP-42 emission factors and Energy Information Administration activity data. Even though NH accepted and incorporated Pechan’s estimates into our 2002 inventory, they did seem quite high.

Thunell stated that he was disappointed that OMNI did not provide a database and/or spreadsheet that shows all calculations estimating RWC emissions. MS Word or Adobe pdf documents presenting data and/or data summaries are not sufficient replacements for spreadsheets/databases. In addition, he is also disappointed that OMNI did not provide any emissions information in EPA NIF format.

*An electronic copy of the database in Excel format was sent to MARAMA in draft form and a final version, pending completion of response to comments, will also be sent to MARAMA. We*

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*are waiting until all comments are in and emission factors are finalized before we start converting the inventories into NIF and SMOKE ready formats.*

Rand noted that The MANE-VU NJ inventory ranges from 184% to 324 % higher than the OMNI inventory, except for VOCs which are 1280 % higher.

## **Section Two: Emissions Factors**

In an email with general comments about the EI TSD Rand stated that she suspects the VOC was high in the Pechan study because of the really high EPA VOC emission factor of 229 lb/ton for fireplaces (which she noted was is really out of proportion with the other contaminants when you compare it to woodstoves). She also noted OMNI used an EPA emission factor of 9.43 g/kg and referenced “U.S. EPA, 2001, Emission Factor Documentation for AP-42: Section 1.9, Residential Fireplaces, EPA-450/4-82-004.” Where is this document? AP-42 for Res Fireplaces on the web is dated 10/96 and does not contain this number and neither does the EIIP. The “Total VOC” = 229 lb/ton may contain methane, which may be why it is so high and out of proportion. Neither AP-42 nor EIIP specify if it includes methane, but the references are old, which leads Rand to believe it was before EPA exempted methane as a VOC. Rand stated that she has also been corresponding with Roy Huntley and Ron Myer regarding this issue and have asked them if total VOC contains methane. She has yet to receive a response. In either case, the emission factor OMNI is using for VOC for fireplaces is much lower.

OMNI Response: The EPA VOC emission factor was in error but OMNI does not agree with the EPA emission factor. Rand stated that Brian answered her question regarding the VOC emission factor for fireplaces, it does not come from EPA as indicated in the first draft, however, Rand still does not understand the date of the EPA reference of 2001. Is the date incorrect? Or if not where is this document?

*The above reference should be E.H. Pechan & Associates, Inc., 1993, Emission Factor Documentation for AP-42 Section 1.9, Residential Fireplaces, EPA Contract No. 68-D1-0146. An email has been sent with the corrected references, as well as the source of the high VOC in AP-42.*

Rand also stated that OMNI did not use EPA emission factors exclusively. OMNI’s EFs are different from MANE-VU as follows:

1. For fireplaces: down 92% for VOC, down 12% for PM, down 41% for CO, up 12% for NOx
2. For conventional woodstoves: down 31% for VOC, up for 11% for PM, down 32% for CO, down 9 % for NOx

The significant decrease in the VOC EF for fireplaces and conventional stoves has a major impact on VOCs.

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The EPA VOC fireplace emission factor is 332 % higher than that of conventional wood stoves, while the other pollutants range from 7 % lower to 13 % higher. This is significantly out of proportion. OMNI appears to agree with this and did not use EPA emission factors.

The AP-42 rating on this emission factor is a “D” meaning “tests performed using a generally unacceptable method, but the method may provide an order of magnitude value for the source.” The AP-42 documentation table 4-1 shows a range of 2.9-184.3 g/kg, quite a wide range. The test was performed with an FID, not a very accurate field instrument (and it measures methane included in the total). And last but not least, it appears as though the VOC EF may include methane, but I can not find any information to answer this question and am waiting for a response back from EPA. The references are from the 80’s, further implying the number may contain methane. AP-42 for woodstoves breaks out the methane as a separate category, while AP-42 for fireplaces does not. The narrative is not clear, but discusses that methane is high in fireplaces and appears to link that to high VOC emissions.

Thunell noted that as stated by both Rand and Merrell in previous comments, some of these emission factors need better documentation and/or justification.

*Each emission factor has at least one reference, many have multiple references. These are either the only sources for an emission factor, or are the sources that are most credible.*

Gee had specific comments about the emissions factors, see her MS excel spreadsheet. She stated that in regards to the centralized wood heater emission factors PA only has about 4.8 million residences. Is OMNI assuming that every other home has two units that use wax fiber firelogs? In regards to fireplaces without inserts PA only has about 4.8 million residences. Is OMNI assuming that every other home has two fireplaces?

*For wax fiber firelogs, 7,241,992 is the total mass of firelogs burned in fireplaces without inserts (kg), not the number of fireplaces without inserts used.*

*For fireplaces without inserts, the number she references for fireplace usage is 7,418,996. From where does this number originate? The number of wood-burning fireplaces without inserts used for heating in PA is 177,004 as shown in Technical Memo 2 (Task 4) Table 3.3.1. This equates to 3.67% of PA households. (Note: this does not include household with gas-fueled fireplaces, cordwood fireplaces with inserts, or wood-burning fireplaces infrequently used for aesthetics or not used in a given year. To give a sense of scale, about 30% of wood-burning households nationwide report that they burn firelogs at least some of the time.)*

### 2.3 Fireplaces without Inserts

Cabrera-Rivera stated that there is a mismatch between Table 2.3.1 and the references; therefore, no way of knowing where the factors came from. A number of the references listed on the table are not included in the reference section. Some are 5.01-5.40, 8.01-8.03, 11.01 through 11.21, 14, and 15. Reference 12 seems to be in error. Section 1.9 from AP-42 is not from 2001, nor includes some of the pollutants listed in Table 2.3.1.

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*The problem with references on Table 2.3.1 has been worked out and fixed. We apologize for the mix up. An email has been sent with the correct references as well as the source of the VOC outlier.*

#### 2.4 Centralized Cordwood Heating Systems

Merrell stated that if this category includes outdoor wood boilers (OWBs), it seems odd that the emission factor for PM (and a number of other pollutants) should be less than the conventional woodstove emission factors. Is it possible that the “centralized cordwood heating systems” emission factors accurately represent “cordwood-fired hot air furnaces” and “cordwood-fired indoor boilers” ... but are too low for the generally less efficient / higher emitting “cordwood-fired outdoor boilers” (OWBs)?

*OWBs are only included as part of the CCHS averages, there was not enough supporting data for OWB to make any assumptions for only OWBs. Calculating the activity and emissions from OWB is outside the scope of work and not feasible due to the lack of available data from unbiased peer-reviewed publications on the topic.*

Merrell also noted that in looking at the “Total dry mass of cordwood burned by centralized cordwood heating systems (kg).” The data seem reasonable for most combustion device categories (e.g., Conventional Cordwood Heaters burned an estimated ~3 tons per unit in VT), but for “Centralized Cordwood Heating Systems,” the value is more like 1 ton cordwood burned per unit (i.e., less than 1 cord of wood per unit). These centralized heating units generally burn far more cordwood per unit (5, 10, 15 cords...) annually, as they are most commonly used as a primary heat source (not as supplemental heat). Adjusting the OMNI emissions inventory to reflect the much higher usage of cordwood by this combustion device category would change the inventory appreciably.

*The low cordwood usage by CCHS is a mistake in Technical Memo 1. An updated fixed copy of tech memo 1 and database have been sent to Angela Crenshaw. The mistake had ramifications in the draft of tech memo 2 that, once fixed, raised the activity and emissions of CCHS. The cordwood usage by the CCHS category is based upon the 2002 MARAMA survey, categorized by HDD. Since minimal data is available on the amount of fuel burned by OWB, their activity is only included as part of the CCHS averages.*

#### **Section Three: Emissions Inventory**

Merrell stated that the statewide individual pollutant totals look good, but the distribution of RWC by county is inaccurately skewed towards Chittenden county (an urban county). In Vermont’s in-house inventory allocation, information from the VT Department of Public Service Residential Fuelwood Assessment was utilized that indicated the mean percent of households in each county with wood-burning devices, as well as the mean number of cords burned per household (county specific). The resulting percent contribution by county can be seen in the attached spreadsheet in the graph entitled “Vermont NEI RWC Benzene Contribution.”

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*County allocations are explained in Technical Memo 1 (Task 3), section 2.9 and 2.10. Chittenden County has a large population, 28% of which is rural, and the Vermont Residential Fuel Assessment shows that 20.5% of the households in Chittenden County use wood for fuel. Even though the county is mostly urban, the large population allows for a higher activity.*

Santal noted how low the numbers are for NJ. In most instances, NJ is lower than CT, MA, and MD but NJ's population is much higher than these states. {Is this reasonable?}

*Wood-burning appliance usage numbers, in part, depends on the fraction of the population that is rural. 94% of the NJ population is urban, so RWC will be lower for that reason alone if all else is equal. The key input data for the county-by-county attribution is from the U.S. Census Bureau long form questionnaire, which obtains responses from one out of 1 every 6 households. This is unbiased and factual. Other factors that can affect the distribution of RWC are climate, differences in fuel availability (coal, natural gas, wood), socio-demographic differences and regulatory history. These are difficult to quantify, hence we relied on the factual, nonbiased and extensive county-by-county survey information provided by the U.S. Census Bureau.*

Santal also noted that the OMNI emissions are generally about half that of the Pechan/MANE-VU emissions for CAPS except for VOC. OMNI VOC is 12% of the Pechan/MANE-VU estimates.

Santal also stated that after reviewing the OMNI report he saw no mention of the Pechan/MANE-VU Residential Wood-burning Study emission estimates.

Thunell noted that the calculation of the number of wood heaters (wood stoves plus fireplaces with inserts) by county that are used (in contrast to owned) were conducted by eight different methods. The calculation of the number fireplaces without inserts used for heat (in contrast to owned or used for aesthetics) were calculated by six different methods. Fireplaces used for aesthetics were not included in the by county calculations because it has been estimated that the usage of cordwood in fireplaces for aesthetics represents less than 10% of the total cordwood used in fireplaces. This part of the OMNI RWC inventory appears logical and acceptable, ensuring that the correct value/method was used for each county is a cumbersome job.

Thunell also made three very specific comments about the methodology used in calculating the cordwood usage per wood heater, see the actual comment for details. He concluded that with the exception of centralized heating systems and outdoor wood boilers, the methodology appears acceptable. He agrees with Merrell that the dry weight of cords burned per central heating systems/outdoor wood boiler appliance appears too low.

*See responses to Merrell's comments in section 2.4 Centralized Cordwood Heating S systems. An error was identified and corrected.*

Thunell noted that multiplying the dry weight of cords burned per appliance by the number of appliances in each county gives the total weight of wood burned for each appliance type by county. The total weight burned by state is the sum of the county numbers.

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According to Rand in general the MANE-VU inventory is too high for PM and other pollutants. Rand does not think the monitors support these numbers. Emissions= 9901 tpy of PM<sub>2.5</sub> due to residential wood-burning is approximately 32 percent of the total NJ PM<sub>2.5</sub> inventory, which is significantly greater than 8 to 10 percent which are the numbers being shown in the monitoring studies. The OMNI total emissions appear to be more in line with monitoring data.

### Summer VOC

According to Rand summer VOC was not that big of a concern previously because the emissions were not allocated in the ozone season. But due to the extremely high numbers in the MANE-VU study, even a small allocation in the summer for indoor burning makes an impact, and now we have included outdoor burning which occurs in the summer. Rand calculated that the indoor wood-burning increases NJ inventory 6.2 tpd ozone season, and the outdoor wood-burning increases it another 7 tpd. Rand also calculated that the seasonal adjustment factors being used by OMNI in the model for indoor burning (1.5%) are higher than those she calculated using HDDs (0.5%), which adds to the increased numbers in the summer. Although 1.5% is small, are people burning wood indoors in the summer? Note: Rand evaluated the 3 month ozone season and a 5 month season would produce even higher VOC values.

Rand stated that the outdoor burning summer allocation is 10% in the model, but 54 % in the MANE-VU inventory. The commenter is not sure why there is a discrepancy, but she is not in favor of increasing it in the model. What did OMNI use for summer allocation factor?

*OMNI did not allocate indoor wood burning by season. Further, outdoor burning is not a part of RWC, and it is outside of our scope of work. We are unsure from where the numbers quoted by Rand came. If Rand is referring to OMNI's previous study entitled, "Monthly Distribution of Residential Wood Combustion," that is posted on our website, HDD by census district was used to proportion RWC emissions by month.*

### Ton to Cord Conversion Factor

Rand stated that Pechan used 1.8 tons per cord as a conversion factor, revised down from 2.1 tons per cord. Per my previous comments in June 2004, NJ used 1.42 tons per cord in accordance with EPA EIIP guidance. For the conversion from cords to tons NJ used 79 cf/cord per EIIP and 35.78 lb/cf (from EIIP Table 2.4-4 Factors to Convert Wood Volume to Weight, using an average of the hardwood only factors for the Northeast and Mid-Atlantic region). Even if the highest hardwood factor is used only of 39.7 lb per cf is used, will you get 1.57 tons per cord. Thus Rand not sure where Pechan got 2.1 or 1.8, they must be using different guidance/factors. This factor can have a big impact on final emissions.

### County Emissions

Rand would like to know more about what OMNI used in calculating county emissions. The OMNI County distribution looks a little off with some of the urban counties like Bergen and Union ranked high, and some rural counties like Cumberland and Gloucester ranked low. In looking at the MANE-VU emissions and it also looks a little off. The commenter did a ranking

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based on NJ/EPA calculations, based on census data for people who use woodstoves for primary heating purposes, which looks the closest to reality, although this method caused zero emission in 5 urban counties, which is also not realistic.

*See the responses to Merrel's comment regarding Vermont and Santal's comment regarding New Jersey (Section 3 Emissions Inventory), which deal with county-by-county allocations. Both discuss the use of the unbiased, factual, extensive U.S. Census Bureau's survey, as well as other available surveys, as the basis of county-by-county allocations and the fact that numerous factors that are often not intuitively obvious impact the RWC activity in a given county.*

#### “MANE-VU Version 3 and Residential Wood Totals”

Rand would like to know more about what OMNI used in calculating the emissions. Rand assumes the emissions are in tons per year?

*OMNI used the number of devices by county, state, and HDD multiplied by the total mass of fuel burned per appliance by county, state, and HDD. Total mass of pollutants is calculated by multiplying the total mass of fuel, in kg/yr, by the emission factor, in g/kg. The final emissions inventory data are in kg/yr.*

Rand thinks the totals used in this worksheet for MANE-VU include outdoor burning, but the OMNI totals do not, is this correct?

*Outdoor burning is not accounted for since outdoor wood burning is not RWC, aside from outdoor wood boilers, which are mainly used for indoor heat.*

#### “RW EI Totals”

Rand would like to know if the residential wood emissions are in kg/year?

*Yes.*

#### OMNI Res Wood Summaries:

Rand would like to know if this sheet includes emissions or emission factors? Are the emissions in kg/year and is the wood mass in kg? Does this represent the total cordwood burned in the state if you add up all the categories?

*This is not OMNI's report, we recommend contacting the author for clarification.*

#### Mass of Cordwood:

Rand wants to compare the mass used by OMNI, Pechan and the DOE. What is the mass of cordwood used by Pechan? I asked Pechan this a few weeks ago and they could not answer the question. What is the mass of cordwood used by OMNI, is it the total on the worksheet “OMNI

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Res Wood Summaries?" When the categories in the OMNI summary table are added, the sum is 213,387,432 kg or 235,219 tons. Is this correct for OMNI?

*Aside from the fact that the number includes pellets, which are not cordwood, the number was correct (before the centralized cordwood heating system category mass was corrected) except the tonnage would be 23,522, not 235,219. The corrected sum for cordwood and pellets is 213,012,836 kg (23,481 tons), whereas the sum for cordwood alone (without pellets) is 207,670,147 kg (22,892 tons).*

### Summary of Rand's Comments

Rand thinks the MANE-VU wood-burning inventory is too high for all pollutants, most likely due to many factors, accuracy of wood consumption, accuracy of EFs, accuracy of conversion factors. Rand thinks the accuracy of the wood consumption will always be in question when you are projecting 115 responses to 8,000,000 people. The results should be compared to monitoring data as a reality check. More monitoring studies are needed. The OMNI total emissions appear to be more in line with monitoring data.

In regards to the VOCs in the MANE-VU inventory, they appear too high proportionally, most likely due to an inaccurate EF. OMNI has used a different VOC emission factor, and the final emissions are more proportional to PM.

In regards to the VOC emission factor, the change does affect summer ozone emissions, based on the current model inputs (13 tpd in NJ).

The OMNI inventory appears to be more realistic on a statewide basis, the county allocation seems a little off.

*See previous comments on county allocation*

While I know changes to the modeling inventory are not desirable at this time, I think at a minimum the VOC should be changed, if agreeable to EPA. To put this in perspective, the additional 13 tpd ozone season in NJ is larger than many of the rules we are proposing added together. The OMNI emissions would also have a large impact on PM emissions, reducing them in NJ by 65%, also larger than the rules being evaluated.

### David Fees Comments

1) Tech Memo #2 - emission factor tables - As the person from WI noted, the references associated with the emission factor table for fireplaces w/o inserts burning cordwood seems to be all messed up. Besides that table, the EPA certified wood heaters with catalyst emission factor table list more references than are contained in the reference list. References are missing for 10.15 through 10.21. In addition, reference 5 is not used in the table. Finally, in the pellet stove emission factor table, reference 6 is not used.

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*The errors in the references have all been fixed.*

While OMNI indicated they would be averaging emission factors from a number of data sources, I notice that for VOCs most equipment types have only one value. Only fireplaces had an average of 4 emission factors. What was OMNI's method for which emission factors to choose and which to not use.

*Each emission factor has at least one reference, and many have multiple references. These are either the only sources for an emission factor, or are the sources that are most credible.*

Under calculation notes at the bottom of Table 2.1.1, the use of the ideal gas equation should be in absolute temperature (Kelvin) not Celsius. At what temperature were the gram/m<sup>3</sup> factors given?

*°C has been changed to K in the ideal gas equation under the relevant emission factor tables. The g/m<sup>3</sup> factors were given at standard temperature.*

2) Tech Memo #2 - looking at wood consumption data for the entire MANE-VU region, I come up with the following annual cord wood usages per equipment type:

conventional woodstoves - 1.65  
certified w/ catalyst - 1.32  
certified w/o catalyst - 1.32  
pellet stoves - 0.88  
fireplaces burning cordwood - 0.75  
fireplaces burning artificial logs - 0.03  
central systems - 0.72

In OMNI's work plan, page 5, they indicate that central systems "burn on the average considerably more cords of wood than wood heaters or fireplaces w/o inserts." These data do not support this statement.

*As stated above in the responses to Merrell's comments in section 2.4 Centralized Cordwood Heating Systems, the low centralized cordwood heating system cordwood usage was due to a miscalculation in Technical Memorandum 1 (Task 3). This error was magnified in Task 4, but has been fixed.*

I tried to compare to Pechan's results. I was having a difficult time finding cordwood usage from the Pechan report documents, but did find data tables in Tech Memo #5 that provide annual wood usage on a cords per HDD basis. Looking at the HDD extremes (roughly 4,000 as the lowest values and 10,000 as the highest values) I get some higher usage values for the low HDD and much higher values for the high HDD. Without being able to review the calculational spreadsheets, I cannot assess OMNI's methods and what initial data they used. There needs to be more documentation. I did go back and read OMNI's TM #1, but that didn't help.

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3) Tech Memo #2 - concerned that OMNI didn't include aesthetic burning. Even though the estimated wood usage is only 0.06 cords/unit annually, the potential number of households that burn for aesthetic purposes may add up to something not insignificant.

*Nationwide, the number of households that use fireplaces for heating as compared to the number of households that use fireplaces for aesthetics is about the same. Anecdotally, we know that in the MANE-VU region the relative number of fireplaces used for aesthetics as compared to heating is smaller, in contrast to those in warmer climates (i.e., California, Texas, and Florida). This is partially due to socio-demographic reasons. As noted, the annual usage of cordwood in a fireplace is approximately 0.06 cords per year if it is used for aesthetics as compared to 0.38 to 1.18 cords/yr in the MANE-VU region counties when the fireplace is used for heating. Further, we have accounted for firelog usage and these are used primarily for aesthetic purposes. The bottom-line is that well less than ten percent of the fireplace cordwood activity in the MANE-VU region is not included in the inventory by not including aesthetic cordwood burning in fireplaces.*

4) Tech Memo #2 - Section 4 - Review of organic compound emissions - While OMNI's work plan indicates that the RFP asks to specifically pay attention to VOC emissions, I think what we were looking for was the issue with the emission factor and the high annual and ozone season daily emissions that we got from the Pechan study. I do not believe we were looking for what they provided. Therefore, I do not believe that it is necessary to include this section. Having said that, what they have provided is an interesting discussion on a topic that is quite the debate with respect to the contribution of SOAs to PM2.5.

*The SOA discussion has been removed. Section 4 is the summary section.*

5) Tech Memo #1 - I believe there may be an error in Table 2 for Sussex County Delaware, the fraction of households having fireplaces without insert. The value seems unreasonably low. I have researched the referenced Delaware survey report and cannot reproduce any of the numbers, but data in the report indicate a greater use of wood usage for primary or supplemental heat for Sussex County as opposed to the other counties. The value is 0.018--is it possible that it should be 0.18?

*The Technical Memorandum 1 (Task 3), Table 2 error has been fixed. The factor of 0.018 for fireplaces without inserts in Sussex County, DE should be 0.0813. Fixing this mistake raised the number of fireplaces without inserts used in Sussex County, DE, and in turn, the amount of wood burned by that category, which had minor ramifications in task 4 as well. This error has been fixed in Task 3 and Task 4.*

6) On page 8 of OMNI's work plan they state "OMNI completed a study which proportioned annual RWC emissions on a monthly basis. the results of this work will be provided in the final report due to the seasonality of ozone and regional haze." this is the only mention I see regarding the summer season. We should see that this is included.

*Yes, we plan to include it as an appendix to the final report (Task 6). It can currently be found on OMNI's web page.*