Background Report Reference

AP-42 Section Number: 10.8

Background Report Section: 4

Reference Number: 20

Title: Personal Communication From Mike Pierce & Michael R. Corn, AquAeter, Inc., To George Paris, American Wood Preservers Institute

September 17, 1998

AP-42 Section
Reference
Report Sect.
Reference 4
20

MEMORANDUM

TO: George Parris, American Wood Preservers Institute
FROM: Mike Pierce, E.I.T. and Mike Corn, P.E., **AquAeTer, Inc.**
DATE: September 17, 1998
JOB NO.: 980694B
RE: **Proposed AP-42 Section 10.8 Document Review**

A report assembled by Midwest Research Institute (MRI) proposes certain updates to the United States Environmental Protection Agency (USEPA) *Compilation of Air Pollutant Emission Factors* (AP-42) Section 10.8 pertaining to the wood preserving industry. The report provides background information on the wood preserving industry, including: **1)** manufacturing processes, emission source characterization, pollutant inventory, etc.; **2)** a review of emission data for the industry, including collection methods and data quality and; **3)** the development of emission factors for the treatment processes.

Review of the sections pertaining to industry and process descriptions has been left to American Wood Preservers Institute (AWPI) members who are more versed in the details of wood treatment methods and industry history.

The primary role of **AquAeTer** in this review is to ascertain the validity of the section of the MRI report pertaining to the development of pollutant emission factors. The four primary areas of development in the proposed AP-42 Section 10.8 document are: **1)** the estimation of fugitive emissions from the open storage of creosote treated wood products; **2)** the development of a Temperature Correction Factor (TCF) to be used in conjunction with the aforementioned fugitive emission factor for open storage of creosote treated wood products; **3)** the development of process emission factors for total volatile organic compounds (VOC) with and without Boulton Process conditioning; and **4)** the development of process emission factors for 15 individual creosote constituents with and without Boulton Process conditioning. The development of process emission factors for the 15 individual creosote constituents is an expansion of the four hazardous air pollutants (HAPs) for which AWPI previously developed emission factors. Only one of the 15 constituents, naphthalene, is a USEPA HAP.

ESTIMATION OF FUGITIVE EMISSIONS FROM OPEN STORAGE OF CREOSOTE TREATED WOOD PRODUCTS

Midwest Research Institute (MRI) utilizes the identical methodology introduced by **AquAeTer** in *Calculated Emissions from Creoste-Treated Wood Products (Cross-Ties and Poles)* (1994) for the estimation of fugitive emissions during open storage of treated wood products. The emissions are approximated by multi-phase exponential curves regressionally fit to data obtained during a 1990 Koppers Industries, Inc. (KII) emissions test at the Oroville, California facility. The original equation was a three curve approximation of naphthalene emissions. The newly proposed equation set differs from previous versions as the data set has been adjusted for corrected sampling times (as per a memo from Steve Smith, KII to Rick Marinshaw, MRI dated July 1997) and simplified from a three curve equation to a two curve equation. Also, the proposed fugitive emissions equations have been expanded to include additional polycyclic aromatic hydrocarbon (PAH) constituents, but do not include 3 of the 4 specified USEPA HAPs.

Although MRI has given acceptable two-stage air emission factors from stored treated wood, a primary component of the emission calculation accepted by USEPA has been omitted. The treated wood storage yard emission factors are multiplied by square footage of wood treated to arrive at a total emissions estimate. However, the manner in which treated wood products are stacked in open storage or stacking geometry is not considered by the proposed emission factors. Stacking geometry greatly limits the surface area available for emissions from treated wood in a storage yard. This mitigates the amount of emissions substantially and this approach has been technically accepted by the USEPA. The proposed fugitive emission factors result in a gross overestimation of total emissions from treated wood storage if based solely on total volume of wood, converted to square footage, treated per year. Additionally, there is some concern with the temperature correction factor (TCF) presented in the MRI document as described below.

Review of the proposed emission equations indicates sound physical and mathematical foundations are observed and obeyed throughout the development. The simplification of the open storage fugitive emissions equations to a two curve approximation will underestimate initial emission rates and quantities because it ignores the initial temperature driven emission phase. During this phase, freshly treated wood rises in temperature upon removal from the retort as it is no longer subject to an applied vacuum. Test data indicate that this phase is short, however, so that the proposed fugitive emission equations should be adequate for long term emission estimations.

The proposed open storage fugitive emissions factors have been developed for only one USEPA specified HAP, naphthalene, for the creosote

industry. Emission factors for the HAPs, dibenzofuran, quinoline, or biphenyl, have not been developed.

DEVELOPMENT OF A TEMPERATURE CORRECTION FACTOR

The proposed AP-42 Section 10.8 document includes a Temperature Correction Factor (TCF) to be used in conjunction with the open storage fugitive emission factor in order to adjust emissions from test conditions to ambient air temperatures at the site to be examined. The proposed TCF is based on Antoine's vapor pressure equation and is as follows.

$$TCF = \exp\left[-11161 * \left(\frac{1}{(T+460)} - \frac{1}{540}\right)\right]$$

Equation 1

where:

TCF = temperature correction factor
T = average temperature in °F

This is precisely the equation **AquAeTer** developed as a TCF for naphthalene in *Calculated Emissions from Creoste-Treated Wood Products (Cross-Ties and Poles)* (1994). As vapor pressure coefficients are chemical specific for pure substances, it would be wholly inappropriate to use the presented TCF on anything other than naphthalene. Each of the other constituents examined for open storage fugitive emissions (i.e., acenaphthene, fluorene, phenanthrene, anthracene, acenaphthylene, fluoranthene, and pyrene) has its own individual vapor pressure/temperature relationship that is entirely different from that for naphthalene. To use a single Antoine's equation to approximate a temperature- vapor pressure relationship for all creosote components has no firm basis.

The need for a TCF to adjust for different site conditions is quite evident, however, simply using the Antoine's equation for naphthalene is not suitable. The best solution would be to adopt individual TCFs for each constituent PAH. A "composite" Antoine's equation may be possible for rough calculations if one assumed chemical ratios and pure substance behavior (i.e., no chemical component interactions regarding vapor pressure). Such an approach would be questionable at best due to the slight variability of creosote composition and the necessary assumptions seemingly in violation of physical/chemical principles.

It may be possible to develop a similar, less responsive TCF curve utilizing data from an American Wood Preservers' Association study [1] on the effects of temperature on the emission rates of creosote treated wood. In the study, emission rates for eight creosote constituents (indene, naphthalene, 2-methylnaphthalene, 1-methylnaphthalene, biphenyl, acenaphthene, dibenzofuran, and fluorene) were measured at different temperatures for identical creosote treated wood samples. The test data, shown in Table 1, indicate that the TCF for creosote as a whole may be more closely approximated by the equation;

$$TCF = \exp\left[-8531 * \left(\frac{1}{(T+460)} - \frac{1}{540}\right)\right]$$

Equation 2

where:

TCF = temperature correction factor
T = average temperature in °F

Also, it should be noted that the temperature for determining corrections of vapor pressure should be that of the chemical compound, which is more accurately approximated by the temperature of the wood than of the ambient air of the region. Ambient air temperatures can be substituted for the creosote temperatures for emissions calculations greater than one day, as long as, site conditions indicate that ambient air temperatures approximate wood temperatures (and therefore creosote constituent temperatures).

PROCESS EMISSION FACTORS

Emission factors for 15 creosote constituents and for total VOCs were developed for activities associated with each of four treatment processes: **1)** conditioning by the Boulton process; **2)** filling the retort with preservative; **3)** returning the preservative to a holding tank from the retort; and **4)** application of the vacuum cycle. Test measurements, or averages of multiple

[1] Ingram L. L., Jr., McGinnis, G. D., Prince, W. E., Gjovik, L. R., and Webb, D. A. 1984. The Effects of Temperature, Air Flow Rates, and Coatings Systems on the Vaporization of Creosote Components from Treated Wood. American Woo-Preservers' Association.

measurements, were used whenever possible. However, complete data for all four steps was available for none of the constituents of interest. In order to fill the voids in test data for a constituent during a particular process step, assumed ratios were calculated relating one process step to another for all constituents of interest. The ratios were formulated using the averages of known test measurements between processes. In this way average process step ratios were developed between: **1)** the preservative filling/air release step and the conditioning by the Boulton Process; **2)** the preservative return/blowback step and the conditioning by the Boulton Process; and **3)** the vacuum cycle and the preservative filling/air release step. These values are shown in Table 2.

The methodology involved assumes constituents behave similarly throughout the wood treating cycle. However, the inconsistent nature of the ratios is evident from the test data. Measured ratios range from 4 percent of the average value (fluorene during the preservative filling/air release step and the conditioning by the Boulton Process comparison) to 297 percent of the average value (anthracene during the preservative filling/air release step and the conditioning by the Boulton Process comparison).

Although the ratio relationships of the treatment processes are not very accurate, as indicated by the variability of the measured ratios that were used to obtain an average ratio, it may provide a reasonable first estimation of emissions when no data are available. MRI seems to recognize the frailty of the method by classifying the emission factors as poor (E rating).

Although the difficulty in determining emission rates when no single complete set of data for all components and all processes exists can be appreciated, it is of some concern that the chosen data sets (VOC data from Kerr-McGee Chemical LLC, Avoca and all constituent chemical data from KII, Susquehanna) and methodology leave the majority of the VOCs unaccounted for in the calculations. The proposed emission factors indicate roughly 2 percent of the VOCs are PAHs. Data provided by GERG indicates roughly 44.6 percent of creosote vapor emissions are comprised of 16-PAH compounds. Thus, the proposed emission calculations indicate that the roughly 44.6 percent of creosote vapor accounts for only 2 percent of VOC emissions (i.e., 100 percent of creosote vapor is less than 5 percent of the total VOC released). That leaves 95 percent of the VOC unaccounted for. It is known that the heat treating of wood releases volatiles from the wood that are not PAHs, but there is no guidance in the document as to whether this release has been addressed. The AWPI emissions estimation program calculates treatment process naphthalene emissions discharged through the condenser as 3 percent of VOC emissions. Non-treatment process naphthalene emissions are calculated as 42 percent of VOC emissions.

Although not immediately apparent, pollutant emissions from treatment processes are given in volume per mass multiplied by an annual production rate yielding an emission rate per year. This should be clearly indicated in the report.

OTHER NOTES OF INTEREST

Naphthalene was the only creosote constituent for which **AquAeTer** developed an emission factor. The emission factors for the other 3 HAPs were based on partial pressure ratios developed from the GERG data. A comparison of the naphthalene emission factor proposed by MRI to the equation developed by **AquAeTer** in *Calculated Emissions from Creoste-Treated Wood Products (Cross-Ties and Poles)* does not result in an increase in naphthalene emissions, if used with the USEPA approved AWPI calculational procedure. Emissions under the MRI equation range from 84 percent (at one day) to 98 percent (at 300 days) of the previous values.

USEPA identified a total of four HAP constituents, naphthalene, dibenzofuran, quinoline, and biphenyl, for reporting under Title V of the Clean Air Act and Amendments of 1990 by the wood treating industry. Of the eight PAHs reviewed in the MRI document, only one, naphthalene, is regulated as a HAP. Since the USEPA industry specified HAPs should be the main thrust of emissions factor guidance provided by AP-42 to the wood treating industry, the proposed emission factor document is misdirected and incomplete as a reference for Title V air emission estimates from creosote wood treating. Guidance for the calculation of the USEPA specified HAP emissions is essential in Title V compliance.

MEMORANDUM

TO: George Parris, AWPI
FROM: Mike Pierce, E.I.T.
Shaleen T. McCormick
Michael R. Corn, P.E.
AquAeTer, Inc.

DATE: September 17, 1998
JOB NO: 980694B
RE: **Additional Comments Regarding the Proposed AP-42 Section 10.8 Document Review**

The following comments are in response to the review of the United States Environmental Protection agency (USEPA) *Compilation of Air Pollutant Emission Factors* (AP-42) Section 10.8 pertaining to the wood preserving industry. These comments are intended for your consideration in addition to those offered in the attached memorandum.

- The proposed treated wood storage yard emission factors are multiplied by square footage of wood treated to arrive at a total emissions estimate. Although, MRI has given acceptable two-stage air emission factors from stored treated wood, the MRI document does not provide any guidance on the calculation of the surface area of wood to be utilized with the emission factor for calculating storage yard emissions. By neglecting such guidance, the implication is that the surface area of wood for storage yard emissions is arrived at by multiplying the number of wood pieces stored by the surface area per piece of wood. This omits a key component of the storage yard emission calculations accepted by USEPA. The manner in which treated wood products are stacked in open storage or stacking geometry is crucial to the calculation of emissions from stored treated wood and is not considered by the proposed emission factors. Stacking geometry greatly limits the surface area available for emissions from treated wood in a storage yard. This mitigates the amount of emissions substantially. Thus, the proposed fugitive emission factors result in an overestimation of total emissions from treated wood storage. Additionally, there is some concern with the TCF presented in the MRI document as described below.

- Although not immediately apparent, pollutant emissions from treatment processes are given in volume per mass multiplied by an annual production rate yielding an emission rate per year.

- USEPA has identified a total of four hazardous air pollutant (HAP) constituents, naphthalene, dibenzofuran, quinoline, and biphenyl, for reporting under Title V of the Clean Air Act and Amendments of 1990 by the wood treating industry. Of the eight PAHs reviewed in the MRI document, only one, naphthalene, is regulated as a HAP. Since, the USEPA industry specified HAPs should be the main thrust of emissions factor guidance provided by AP-42 to the wood treating industry, the proposed emission factor document is misdirected and incomplete. Guidance for the calculation of the USEPA specified HAP emissions is essential in Title V compliance.

- MRI has presented emission factors for PAHs that have not been identified as significant HAPs e.g., anthracene, fluorene, pyrene, etc. This presentation may raise new issues beyond the four HAPS accepted today.

- The USEPA AP-42 guidance document is much simpler than the AWPI Emissions Guidance Document. The AWPI Emissions Guidance Document examines in detail the processes, controls, timing, and equipment involved in the manufacture of creosote treated wood products. By evaluating a site using the AWPI Emissions Guidance Document, specific areas of concern can be identified and emission control strategy implemented.

- A comparison of the storage yard emission calculations was performed using known plant production schedules and average ambient air temperatures from a sample creosote wood treating facility. Results are presented in Tables 1A and 2A. The MRI Proposed Storage Yard Emissions Calculations, as presented in Table 1A, are calculated in accordance with the proposed AP-42 guidelines. Since no guidance was offered in the proposed document regarding the calculation of treated wood surface area available for emissions in the storage yard, the surface area is determined by multiplying the number of wood pieces stored by the surface area per piece of wood. The Amended Storage Yard Emissions Calculations, as presented in Table 2A, are calculated with the proposed emission factors, an amended TCF, and the inclusion of stacking geometry adjustments of available surface area.

- The MRI document makes no distinction between ties and poles regarding stacking geometry and age distribution. The stacking geometry and age distribution of treated ties is based on the following assumptions.

    - Treated ties are placed in storage only during the months of December to March, at the beginning of each month.
    - Treated ties products are shipped only during April to November
    - The oldest treated ties are shipped first, at the beginning of each month
    - One unit consists of 652 stacks of 144 ties or 93,888 ties total.
    - One 652-count unit (93,888 ties) is treated each month.
    - Ties, bundles, and stacks are stored in such a way that only outside surfaces have the potential to emit.

- The area emission source is calculated as six 48-crosstie units stacked three high and two wide. The total area available for emissions from this unit source is 542.5 square feet.

♦ The stacking geometry and age distribution of treated poles is based on the following assumptions.

- The inventory of poles is relatively stable throughout the year. Poles are inventoried for three months.
- Pole bundles and stacks have the potential to emit from five surfaces. Bottom emissions are accounted for as sides and ends.
- A maximum inventory of 2,000 poles is on-site at any one time.
- The same number of poles are treated and shipped off-site every month.
- The oldest treated poles are shipped first, at the beginning of each month
- All poles are laid out; 100 poles per layout; 36 hours per layout.
- Trapezoidal stacks of 80 poles each supported by a pole riser with an external surface area of 2,856 square feet.
- All heights are from ground level for determining surface area.

♦ A comparison of process point source emissions calculations was performed using known plant production data from a sample creosote wood treating facility. The emissions calculations in accordance with the proposed AP-42 guidance document result in total VOC emissions of 12,317 lb/yr with 168 lb/yr being naphthalene. Calculations using the AWPI emissions estimating program for the same site result in a total VOC emission rate of 9,006 lb/yr with 3,782 lb/yr being naphthalene. The difference in VOC emission rates can be attributed to oversimplification of source emissions. The difference in naphthalene emission rates can be attributed to the development of the proposed naphthalene emission factors from data acquired from a facility (Koppers Industries, Incorporated, Susquehanna) that utilizes condensers on emission sources that other facilities, such as this example facility, may not. The effect is to assume VOC emissions from all sources are approximately 3 percent naphthalene when in reality some process release VOCs that are 3 percent naphthalene while others release VOCs at 42 percent naphthalene. This assumption has not been directly pointed out in the comments on the MRI document.

In conclusion, the storage yard emission factors developed by MRI must include stacking geometry and age distribution factors in the AP-42 calculation procedure. MRI omitted emission factors for three of the HAPs identified by the USEPA, but have includd non-HAP PAHs. It is essential to redirect these efforts to provide emission estimates for all four HAPs identified by the USEPA. The inclusion of the non-HAP PAHs appears irrelevant at this time. Finally, emission factors for the production processes are in agreement with the USEPA calculations for VOCs and naphthalene discharged through the condenser at the Kerr-McGee Chemical LLC Avoca, Pennsylvania facility.

TABLE 1. AVERAGE AIR CONCENTRATION OF VOLATILE CREOSOTE COMPONENTS (mg/m3)

COMPONENT	TEMPERATURE (°C)			
	20.3	**26.1**	**32.5**	**37.8**
Indene	10.7	12.5	13.6	16.7
Naphthalene	87.1	111	141.9	198.3
2-methylnaphthalene	13	17.8	25.3	36.7
1-methylnaphthalene	4.9	7	10	14.5
Bipheyl	1.3	1.9	3	4.3
Acenaphthene	2.3	3.6	6.6	9.4
Dibenzofuran	1.2	1.6	3.6	4.3
Fluorene	0.5	0.9	1.7	2.9
Total	121.0	156.3	205.7	287.1

Airflow = 1.0 L/min.
Rel. Humidity = 42.5% +/- 5%

AWPA.XLS

AVOCA

TABLE 1A - MRI PROPOSED STORAGE YARD EMISSIONS CALCULATIONS

Month	No. of Black Tie	Total Yard Surfa Area (ft2)	Average Temperature (°	Temperature Correction Facto	Naphthalene Emissions (lbs)
1	120,688	2.84E+06	25.2	0.097	1,734
2	141,566	3.33E+06	26.8	0.104	2,194
3	145,522	3.43E+06	36.1	0.161	3,466
4	126,767	2.98E+06	48.3	0.276	5,180
5	102,787	2.42E+06	58.6	0.426	6,497
6	96,116	2.26E+06	67.4	0.610	8,699
7	93,976	2.21E+06	71.8	0.727	10,133
8	82,118	1.93E+06	70.0	0.677	8,246
9	64,267	1.51E+06	62.8	0.507	4,829
10	62,508	1.47E+06	51.7	0.319	2,956
11	67,791	1.60E+06	40.9	0.199	2,003
12	86,160	2.03E+06	29.7	0.120	1,529
nnual Tot	1,190,266	2.80E+07			57,464

Assumes a black tie dimension of 8.5 feet x 9 inches x 7 inches.

TABLE 2A - AMENDED STORAGE YARD EMISSIONS CALCULATIONS

Month	No. of Black Tie	Total Yard Surfa Area (ft2)	Average Temperature (°F	Temperature Correction Facto	Naphthalene Emissions (lbs)
1	120,688	300,211	25.2	0.168	318
2	141,566	352,145	26.8	0.178	395
3	145,522	361,986	36.1	0.247	564
4	126,767	315,333	48.3	0.373	742
5	102,787	255,683	58.6	0.521	839
6	96,116	239,089	67.4	0.686	1033
7	93,976	233,765	71.8	0.784	1154
8	82,118	204,269	70.0	0.742	955
9	64,267	159,864	62.8	0.595	599
10	62,508	155,489	51.7	0.417	409
11	67,791	168,630	40.9	0.291	310
12	86,160	214,323	29.7	0.197	266
nnual Tot	1,190,266	2,960,787			7,583

FACILITY.XLS

TABLE 2. MEASURED PROCESS STEP RATIOS

POLLUTANT	PRESERVATIVE FILLING/AIR RELEA TO CONDITIONING BY THE BOULTON PROCESS	RESERVATIVE RETURN/BLOWBAC TO CONDITIONING BY THE BOULTON PROCESS	VACUUM CYCLE TO PRESERVATIVE FILLING/AIR RELEASE
VOC	-	0.0131	-
Acenaphthene	0.0140	-	-
Acenaphthylene	-	-	-
Anthracene	0.1000	-	0.35
Benzo(a)anthracene	-	-	-
Benzo(b)fluoranthene	-	-	-
Benzo(k)fluoranthene	-	-	-
Benzo(a)pyrene	-	-	-
Carbazole		-	-
Chrysene	0.0695	-	0.85
Dibenzofuran	0.0124	-	2.44
Fluoranthene	-	-	-
Fluorene	0.0013	-	4.69
Naphthalene	0.0084	-	4.84
Phenanthrene	0.0300	-	4.38
Pyrene	-	-	-
Average Value	0.0337	0.0131	2.93

DATA.XLS