AP-42 Section Number: 1.10

Reference Number: 21

Title: Letter and attachments to Susan Stamey-Hall, Radian Corporation, from Robert C. McCrillis, US EPA, concerning VOC emissions from wood stoves

McCrillus, Robert C.

US EPA

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1.10

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
National Risk Management Research Laboratory
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Air Pollution Prevention
and Control Division

May 8, 1995

Susan Stamey-Hall
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Dear Susan:

This is in response to your letter of May 5, 1995. Let me first address some general assumptions I have made concerning which data I used to calculate average VOC and methane emission factors for woodstoves. Then I will address the data in the reports I chose and, finally, the averages calculated.

Since the late 1980s when EPA started obtaining field data on woodstoves, we have chosen those data whenever available over laboratory-generated data, for inclusion in AP-42. Unfortunately, we have almost no field data on VOCs. The next best choice would be laboratory data gathered while burning cordwood in a simulated home situation. The last choice would be laboratory data generated while burning EPA Method 28 dimension lumber for certification-type tests. Since we have no field VOC data for conventional and catalytic woodstoves, this led me to select AP-42 references 14 and 17, since they used cordwood for fuel and operated in a simulated home cycle. References 13 and 18 used EPA Method 28 test fuel so I did not use those data. Following Method 28 procedures and using the specified test fuel results in a very hot stove at the start of a test. This causes rapid evolution of gases and, I think, results in potentially higher VOC emissions than would be produced by most people in normal home operation. Finally, I selected a recently published report containing field data for noncatalytic Phase 2 woodstoves.

AP-42 references 14 and 17 were run under my direction as the EPA Project Officer. These tests used different conventional stoves. They were also operated by different people so there is considerable chance of variability between the data sets. As operated, the reference 14 stove had higher particulate emissions compared to the conventional stove used in reference 17. There was also more variability in the results, which may have been at least partially due to the fact that the reference 17 stove was tested by an EPA-accredited woodstove test laboratory, whereas the reference 14 stove was not. This in no way makes the data in reference 14 suspect, just more variable. In contrast, the conventional stove tested in reference 17 was cleaner burning than most conventional stoves tested in the field, especially considering that we included cold startup in the tests. Here again, I think this is at least partially a reflection of the testers. People trained to test stoves unconsciously strive towards achieving a clean burn. Without realizing it, they tend to operate the stove they way it should be, the way the EPA brochures tell you to

operated a stove to produce less emissions. In balance, I think the two studies, taken together, result in reasonably average emission factors.

Paula Fields, E.H. Pechan, evidently felt the reference 14 data were too uncertain to use in AP-42. I talked to her extensively while she was gathering and analyzing data for the previous revision to AP-42 but was unaware of her decision. After rereading page 122 of the reference and my recollection of the events as they occurred, I think she may have misinterpreted RTI's remarks. The problems RTI refers to were (1) a pump that didn't work on Run #1 (only) and (2) difficulty in getting the analytical laboratory to analyze the VOC samples and report the results properly. I believe this in no way jeopardizes the data quality, however. Therefore, I have selected references 14 and 17 as the basis for calculating VOC and methane emission factors for conventional and catalytic woodstoves.

The final reference I selected was a report published since the last AP-42 update. This report contains field data gathered in Crested Butte, CO, by Virginia Polytechnic Institute and State University. VPI collected the samples in Tedlar® bags, without realizing that the samples could degrade if kept more than a few days. By the time the samples were analyzed, some degradation had occurred. They did a study to determine the rate of change in concentration and corrected the results but this still leaves some uncertainty. These are, to my knowledge, the only VOC data available on Phase 2 noncatalytic woodstoves. I did not use the Phase 2 catalytic results obtained by VPI since they found that the catalytic stoves' emission control performance had degraded significantly (the stoves had been in use for 4 years at the time of the tests).

I have described my basic assumptions (use field data - if not available, then use laboratory data burning cordwood) and discussed the three reports I used as references. The last topic to be addressed is the data averages. After reading your letter, I brought up the spread sheet with the reference 14 and 17 data. Upon review, I discovered I had made a mistake in the averaging equation I used. Correcting this (fortunately, I guess), did not make a significant change in the averages. The complete table is attached for your review. Data columns 1-10 are from the RTI report (AP-42 reference 14); data columns 12-23 are the OMNI data (AP-42 reference 17). In summary, the values obtained are:

Stove type	Emissions, g/kg (lb/ton)	
	Methane	Nonmethane VOC
Conventional	15 (30)	26.5 (53)
Phase 2 catalytic	5.8 (11.6)	7.5 (15)
Phase 2 noncatalytic	8.0 (16)	6.0 (12)

I appreciate the opportunity to comment on your analysis and hope that the above review is beneficial and explains my train of thought. Please contact me if you have any questions.

Sincerely Yours,

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Enclosure

cc: Roy Huntley (MD-14)

This is a summary of VOC, C1-C7, and C1 data from IACP source laboratory test programs.

CONTRACTOR	RTI DATA: units are g/kg dry wood											OMNI DATA: units are g/kg dry wood													
RUN NO	1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	12	13	14	16
TCO	1.9	11	10.5	2	20.8	0.5	5.7	16.1	11.7	12.7		3.5	2.3	2.4	1.4	2.1	1.3	1.1	1.2	7.6	2.2	1.1	2.5	4.3	2.3
C1-C7		135	101	12	79	4	33	77	82	101		9.6	10.0	17.2	4.3	9.1	5.4	7.5	6.7	33.9	9.8	14.3	8.8	19.2	9.2
%C2-C7		49.6	53.7	77.1	56.4	53.2	57.5	56.3	54.5	52.9		100.0	80.8	72.7	66.7	81.0	55.6	58.3	61.9	50.0	68.8	47.4	52.9	65.6	77.8
TCO+C2-C7, conv A, Oak	1.9	78.0	64.7	11.3					56.4	66.1															
METHANE		68.0	46.8	2.7	34.4	1.9	14.0	33.6	37.3	47.6	0.0	0.0	1.9	4.7	1.4	1.7	2.4	3.1	2.5	16.9	3.1	7.5	4.1	6.6	2.1
TCO+C2-C7, conv A, Pine					65.4	2.6	24.7	59.5																	
C1-C7 g/hr												13	26	22	9	21	9	24	21	40	16	19	17	32	27
C2-C7 g/h												13	21	16	6	17	5	14	13	20	11	9	9	21	21
BURNRATE, kg/hr	5.85	1.02	2.3	4.45	1.59	4.5	4.73	1.48	1.45	1.01		1.35	2.59	1.28	2.09	2.31	1.66	3.18	3.14	1.18	1.63	1.33	1.94	1.67	2.92
TCO+C2-C7,conv B,Pine																9.5	4.3	5.5	5.3	24.5	8.9			16.9	9.5
TCO+C2-C7, cat, Pine																						7.9	7.1		
TCO+C2-C7,conv B,Oak												13.1	10.4	14.9	4.3										
Avg. VOC	28.5 g/kg conventional stoves																								
Avg. VOC	7.5 ,g/kg catalytic stove																								
C1, g/kg		68.0	46.8	2.7	34.4	1.9	14.0	33.6	37.3	47.6		0.0	1.9	4.7	1.4	1.7	2.4	3.1	2.5	16.9	3.1	7.5	4.1	6.6	2.1
Average C1, g/kg, conventional	15.0 g/kg conventional stoves																								
Average C1, g/kg, catalytics	5.8 g/kg catalytic stoves																								
C1, g/hr	0.0	69.4	107.6	12.2	54.8	8.4	66.3	49.8	54.1	48.0	0.0	0.0	5.0	6.0	3.0	4.0	4.0	10.0	8.0	20.0	5.0	10.0	8.0	11.0	6.0
Average C1, g/hr, conventional	23.8 g/hr conventional stoves																								
Average C1 catalytics	9.0 g/hr catalytic stoves																								