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ATTACHMENT H TO HEARTH, PATIO & BARBECUE ASSOCIATION COMMENTS

Shelton Research, Inc. "Sources of Variability in Emissions Test Results" (undated), *previously docketed as* EPA-HQ-OAR-2009-0734-0263

SHELTON RESEARCH, INC.
1517 Pacheco Street
Santa Fe, New Mexico 87501

SOURCES OF VARIABILITY IN EMISSIONS TEST RESULTS

Interlaboratory reproducibility is extremely important in an emissions regulation program. Oregon DEQ has expended considerable effort to assess and assure interlaboratory reproducibility.

As the Committee and EPA finalizes its standard and starts accrediting laboratories it is appropriate to consider all the possible causes of differences in reusults among laboratories. Careful consideration of these issues will help put into perspective many issues now being considered by EPA -- particularly laboratory accreditation, audits and challenges, and altitude.

1) Not all individual stoves of the same model will perform the same. Normal manufacturing tolerances will affect performances through:

-tightness of permanent joints, both welded and cemented,
-dimensional tolerances, such as in air inlets and air distribution manifolds,
-tightness of make/break seals, including bypass dampers, doors, combustor access panels, and removable cook tops.

A few years ago SRI purchased nine "identical" stoves with "continuously" welded seams. Extensive smoke bomb testing and welding was necessary to make all the stoves tight.

The effects of variable tightness can be very large. For instance, if a bypass damper in a catalytic stove is 95% tight, the 5% of the smoke which does not go through the combustor will double the emission rate of a stove whose emissions would be 1.5 g/hr if the bypass were tight. In general, manufacturing tolerances may often affect emissions by 2 to 4 g/hr, which is 50 to 100% of Oregon's passing grade for stoves.

2) Even when the same stove is tested at different laboratories, it is unlikely that the stove will perform the same. Slight warpage in doors can cause minimum heat outputs to be three times larger than normal; combustion efficiencies at identical heat outputs can also be different because the air enters the stove at a different location.

A particular stove used in safety round-robin testing has a cast-iron baffle plate which has roughly 1/4 inch freedom of movement. Its position has a significant effect on safety test results.

Stoves used by Oregon in some of its proficiency testing have arrived at participating laboratories from other laboratories with 1) totally decayed (essentially absent) bypass damper gasket, and 2) with substantial warpage of internal parts. As discussed above, bypass damper leakage can have a very large effect on emissions.

Creosote accumulation inside stoves can help seal up cracks. Thermal stress and time can cause furnace cement to crack and fall out of joints.

Again, there has been no research quantifying these types of effects, but it is plausible that use and natural aging of stoves can effect emissions by at least a factor of two.

3) All standard test methods allow ranges for many parameters. Few of the ranges in the Oregon standard have been investigated to determine their importance. Examples are:

-Fuel moisture may be between 19 and 25% (dry basis).
-Charcoal bed may be between 20 and 25% of the weight of a test load.
-Fuel load weight may range over 20%.
-The specific gravity of the Douglas fir fuel may range from .45 to .60 (a 29% range relative to the midpoint).
-The degree of charcoalization of the charcoal bed is a subjective judgment. It is plausible that the initial condition of the charcoal affects emissions.
-The lateral placement of fuel loads is not specified in the standards.
-The Oregon Method does not specify air settings or whether the door is open or closed during the first five minutes of the test.

There is likely to be a significant difference in the results between two tests wherein each parameter is taken to the clean-burning extreme and the dirty-burning extreme. Again, no research has been conducted on these variables. The cumulative effect of these and other similar variables is likely to be at least 25%.

4) Much of the data available from laboratories is probably selected data. Manufacturers will often have more than the required four tests conducted and select the four cleanest tests for submission to Oregon. In order to have the fairest comparison of data, SRI has used a similar selection process for its data which was generated as part of government-sponosred research projects. Thus the attempt has been made to put the data on an equal footing, but it is likely that unequal data selectivity effects remain and are the source of some of the differences between laboratories. In general, data selectivity can have effects at least as large as 45%, but perhaps more typically 15 to 30%.

5) An indication of the data scatter due to measurement methods alone is evident in the test mthods comparison data, particularly the SRI, OMNI and EPA data on OM-7 in the stack and the ASTM method for PM. Here every data point represents the identical stove, fuel parameters and operating conditions since each point represents data taken during the same tests. Thus the data represents a lower limit on the scatter inherent in one or both of the measurement methods and is almost certainly less than the lab-to-lab variability.

This data indicates that each test has a 38% chance of yielding an emission rate more than 20% different for the average emission rate.

6) Even if all other variables were perfectly controlled, the inherent variability in chunkwood combustion will still result in variable emissions from test to test. Sometimes the front of the fuel load will collapse early in the burn cycle; other times the top piece will not have fallen by the end of the cycle. The degree of charcoalization of fuel at the end of each test is variable. These and similar peculiarities of chunk wood combustion probably result in variable emissions by roughly 20% although it has not yet been possible to isolate this variable from the others.