Results of the 2018-2019 USEPA Burn Wise Residential Wood Heater Testing Laboratory Proficiency Test

Stack Test Solutions, LLC
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John F. Buresh
Principal Research Scientist

Introduction

Stack test Solutions (STS), sole provider of the 2018 -2019 USEPA Burn Wise Proficiency Test Program, began with proficiency testing at the first laboratory in March of 2018. This round of the proficiency testing was completed with the final report submitted from the last laboratory in June of 2019. In all, eight laboratories participated in the program to remain on the USEPA list of accredited Residential Wood Heater Testing Laboratories in the Burn Wise program. Those eight include (in alphabetical order):

ClearStak

Danish Technical Institute

Intertek

OMNI-Test Laboratories

PFS Teco

Poly-Tests Services

Research Institute of Sweden

Strojirensky Zkusebni Ustav

It should be pointed out that the proficiency test was performed at one lab for each of these companies. If any of these companies have more than one lab performing wood certification STS cannot verify nor ascertain the same techniques or lab setup or testing equipment at any satellite laboratories of these companies. STS submits this final report to satisfy the requirements of the USEAP Burn Wise Proficiency Test Provider requirements as described in the USEPA protocols.

Materials and Methods

Special acknowledgement should be given to Indeck Energy, who provided the pellets for both the conditioning burn and the pellets for the test burn. Indeck reserved pellets for the conditioning burn from the same run the test burn pellets were taken. The pellets were predominantly from oak trees with some maple and possibly small amounts of birch. These made for consistent pellets and a pellet that held up well. The pellets were ¼ inches in diameter and between ½ inches to ¾ inches long. All pellets were taken within a half an hour of each other from the pelletizing and bagging line. While the conditioning pellets were shipped “as is”, care was taken with the test burn pellets to store them in nominal 5 pound hermitically sealed, evacuated storage bags to ensure

there was no moisture or oxidation degradation between pellets burned in March of 2018 and April of 2019. Pellets were shipped near the testing date to ensure pellets would not have time to degrade even if the vacuum seal was lost due to shipping.

All single use audit samples (filters and solution) were procured from ERA-QC in Colorado. ERA-QC is a well-known provider of environmental sampling audit materials. Filter audit samples were 47mm glass fiber filters with a known quantity of a white dry material on the surface. The probe wash audit samples were comprised of water-soluble materials in a 250 ml container. It is hoped that for future audit samples, ERA-QC can provide a suspension in acetone sample. These were sent in advance of the proficiency test so STS could observe the final weight on site.

The probes were comprised of 316 stainless steel and stored in a sealed container wrapped in lint free cloth. They were identified with scribed markings. STS employed Barr Engineering to certify the accurate mass of each probe to 100 micrograms.

STS arrived at the laboratories on Monday mornings, and after introductions, provided the staff with the audit samples, the calculations sheet and operating parameters provided by the USEPA, and begin the proficiency test. The Proficiency test included all activities described in the USEPA Protocols: Observation of laboratory technique, equipment set up, cleaning activities, sample recovery activities and inspection of the all equipment associated with the testing as it pertained to ASTMs 2515 and 2779. STS remained at the testing location during all of the testing periods, and followed the sample throughout the stages of recovery until the final deposition in the desiccating trays.

Upon completion of the final test run, STS affixed seals on the stoves and provided the laboratories with a final review of observations and allowed time for any follow-up questions. STS collected the final results of the calculations sheets, and documented the final analysis of the audit samples. Several weeks later, the laboratories provided STS with draft reports that were finalized shortly thereafter.

Upon receiving the final report, STS calculated the Dixon outlier test on the gram per kilogram fuel combusted emissions of each individual test run, and found that no individual run was an outlier from the data set of the 24 runs (Attachment 1).

Discussion

Stack Test Solution (STS) attended all activities of the USEPA protocols in person with the exception of one probe wash audit. The Laboratory in question did not pass the initial probe wash audit portion of the test and was required to redo that portion of the proficiency test. All activities of the redo, including the opening, decanting, handling and weighing were observed via a Skype connection. The Laboratories are de-identified by a color code. STS retains the actual data under the laboratory name for records kept at STS company offices. The color-coded final results can be found in Table 1.

At all of the participating Laboratories, STS inspected the wood stoves, the mixing and sampling ductwork, the external sensors, the sampling trains, and the recovery areas to ensure they met the standards in ASTMs 2515 and 2779. STS utilized a checklist that was developed from requirements found in ASTMs 2515 and 2779.

STS observed minor discrepancies from the ASTM methods from lab to lab, but observed nothing that we believe would invalidate the results of the testing, or overly bias the results. STS also encountered a wide variety in experience and method familiarity between the labs. Differences in comfort with the technique as well as sampling equipment were also displayed. In spite of these differences, STS found all labs and staff were capable of performing the testing.

No laboratory was without findings or deviations from the written Method. Some findings we were able to correct immediately. Corrections such as locations of thermocouples, or pitot markings were corrected on the spot. Several labs had inappropriate transition elbows between the mixing duct and the sampling duct. They agreed to correct that in the near term and be ready for inspection at the next round of proficiency testing. Several labs utilized Method 5 sample trains, which are not nominally designed to sample at rates near 5-10 liters per minute (lpm), and calibrations were not appropriate for the sampling range.

Other examples included:

1. Using a straight pitot instead of a standard pitot.
2. A stove calibration weight that is too small for normal loading of fuel.
3. A probe brush too short to recover entire probe.
4. Room air sample location outside of required distance.
5. Not leak checking for the entire 60 seconds.

6. Sampling ducts too wide to both meet the velocity and volume of air sampling.
7. Piecemeal sampling system that did not have all the parts in the Method.
8. Hood conical area not meeting 4X diameter of chimney requirement.
9. Anemometers not scaled low enough to meet Method specifications.
10. Covering traverse port during testing.
11. Inadequate temperature monitoring.
12. Sample probe location inaccurate.
13. Unsafe sample platforms.
14. Rubber connection between front and back filters.
15. Filter exposed for longer than 2 minutes during recovery.
16. Various deficient laboratory techniques.

All of these findings were documented and reviewed with the laboratory managers in their respective labs.

Conclusions and Suggestions

The 2018 and 2019 USEPA Burn Wise Proficiency Testing Program was the first of its kind and there were many decisions made during the first few tests that provided a better and more worthwhile proficiency test. STS believes going forward, all parties (laboratories, STS and the USEPA) with have a better handle of the entire process and be able to streamline procedures. The laboratories allowed me to review technique and equipment, and as some of this could be considered proprietary, STS tried very hard to avoid any documentation that might identify the individual laboratory. STS concludes that all the results are accurate and represent actual testing and procedures of the individual laboratories.

Below I have provided ideas suggestions for the USEPA to consider for future proficiency testing under the Protocols the EPA might consider when developing the protocols for the next round (2020-2021):

1. The Dixon Test we are using to identify outliers suggests that 8 samples be a minimum number to use in the test, as it is a significance test, not a confidence test. The USEPA decided to consider each test run to be an independent variable rather than the average of the three runs from each laboratory to improve the statistical strength of the analysis. While this is not an unreasonable decision, it presumes each run is independent of the prior run. Observations in the field indicated that since the burn pot in the stove was not cleaned after each run, the prior run possibly influenced the proceeding emissions value. Field

observations recorded one combustion pot was so fouled the stove could not re-light until the pot was agitated with pellets in the ash to allow for initial start-up. Be that as it was, the Dixon test did not find any of the 24 runs outliers due to the wide variability of the test runs. The mean was 2.00 grams per kilogram with a standard deviation of 0.727 grams per kilogram. If the next protocols are using this scheme to identify outliers, **STS suggests that both the combustion pot as well as the duct be cleaned prior each run** to reduce this variable.

2. For the Probe analysis of the Protocols, a 2% error limit was overly liberal, considering the probes were 39-45 grams in mass. For the next proficiency test, STS suggests using a Dixon test on three separate probe challenges to each lab. STS will present the probes on day one and the labs will have three days to achieve final weights. If final weight cannot be met while STS is on the premises, they can be finished as per protocols approved by the EPA for remote viewing of laboratory practices. **STS suggests calculating the outlier based on those 24 independent measurements.**

3. The calculations data set proved problematic for many of the laboratories. Their spread sheets were not designed to take single points. Some found the only way to calculate the results was by hand instead of the spread sheets they normally use. The rounding conventions and carrying of significant figures in the answer sheet did not seem to follow USEPA conventions. Perhaps STS can work with the USEPA developing the answer key in the next calculations sheet to ensure we understand them well enough to provide guidance to the laboratories. **The USEPA might want to consider either creating a data set of 60 data points for an hour of simulated testing of the data that a laboratory must collect on a run, and challenge the laboratory in that manner, or possibly drop this portion of the test.**

4. STS will work with audit sample providers to find a proper audit sample with suspended particulate in acetone for the labs that recover the sample equipment with solvent for gravimetric analysis.

5. STS recognized room air balance and combustion air might be mitigating factors in combustion efficiency for these small stoves. To eliminate this, **STS suggests USEPA to consider requiring these stoves be attached to an unobstructed outside air source.**

6. STS suggests the USEPA requires **a flow to be performed prior to each run.**

7. STS requests guidance whether the leak check should occur with the flow meter (rotameter) or the dry gas meter

8. Examining the first runs from each laboratory, it appears two or possibly three laboratories would not pass the Dixon test and would have been identified as outliers. Allowing for three runs protects the labs from a very unforgiving statistical analysis. **STS suggests the USEPA considers maintaining the 3 run course.**

9. Three-hour test runs allow the Laboratories to complete testing in two days. If the EPA wants greater mass collected on the filters, they could consider going up to four-hour test runs. Five-hour test runs would require the laboratories to have three days of testing.

10. The back filter never collected any measurable particulate, and in many instances actually subtracted from the total catch. I presume this requirement is for wetter wood testing when there is a greater chance of condensable material captured.

11. STS recognized some laboratories chose to induce draft in the chimney to a number just below the ASTM limit of 1.25 Pa (0.005 inches of water). STS is not certain what that does for combustion, but it probably has an effect**. STS suggests the USEPA considers dropping that limit to 0.25 Pa (0.001 inches of water) to eliminate that effect.**

12. The stove has a 1-9 setting with one being lowest and 9 being highest. The laboratories operated at #4 setting for the tests. There was some variability that might be innate or due to some other lab parameter, possibly room air balance or draft induction. **STS suggest EPA selects a number (1-9) for the proceeding rounds of testing.**

13. Required sample flow rate was an issue last year, as the EPA requested one at 10 lpm, when the method does not allow greater than 8.8 (LPM). There were some labs that did not equipment to reach the 10 LPM rate. **STS suggests the EPA provides STS with ample time to review protocols in advance of the proficiency tests to insure appropriateness of the test parameters.**

STS looks forward to discussing these conclusions and suggestions prior to the start of the 2020 -2021 Burn Wise Proficiency testing.

Table 1

		Red			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	3.230	2.400	2.120	2.815	
grams/kg	3.590	2.400	2.100	2.995	
Blank Value					+0.7 mg
Probe Error					0.00284%
Filter Error					-0.2 mg
Probe Wash Error					NA

		Pink			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	2.050	2.370	2.060	2.210	
grams/kg	1.380	1.660	1.160	1.520	
Blank Value					-0.5 mg
Probe Error					NA
Filter Error					-0.1 mg
Probe Wash Error					-0.5405%

		White			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	3.826	5.435	4.237	4.631	
grams/kg	2.695	3.592	3.027	3.143	
Blank Value					0.0 mg
Probe Error					-0.02954%
Filter Error					-0.6 mg
Probe Wash Error					NA

		Black			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	2.880	3.360	3.460	3.120	
grams/kg	1.800	2.100	2.300	1.950	
Blank Value					0.0 mg
Probe Error					0.00154%
Filter Error					+0.1
Probe Wash Error					NA

Table 1 (cont.)

		Orange			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	2.281	2.368	2.454	2.325	
grams/kg	1.481	1.554	1.554	1.518	
Blank Value					0.0 mg
Probe Error					0.00205%
Filter Error	+1.1 mg				+1.1 mg
Probe Wash Error					NA

		Blonde			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	1.620	2.380	3.600	2.000	
grams/kg	1.290	1.870	2.690	1.580	
Blank Value					0.0 mg
Probe Error					0.00189%
Filter Error					-0.5 mg
Probe Wash Error					NA

		Blue			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	2.720	2.260	2.760	2.490	
grams/kg	1.860	1.860	2.050	1.860	
Blank Value	0.1 mg				0.1 mg
Probe Error					0.00283%
Filter Error	-0.5				-0.5
Probe Wash Error					NA

		Brown			
Parameter	Run 1	Run 2	Run3	Mean	Values
grams/hour	1.332	1.242	2.541	1.287	
grams/kg	0.964	0.887	1.821	0.9255	
Blank Value					+2.07 mg
Probe Error					NA
Filter Error					-0.97 mg
Probe Wash Error					1.67%

Attachment 1

Outlier Tests for Selected Uncensored Variables

User Selected Options

Date/Time of Computation	ProUCL 5.15/7/2019 7:48:00 PM
From File	WorkSheet.xls
Full Precision	OFF

Dixon's Outlier Test for C2

Number of Observations = 24

10% critical value: 0.367

5% critical value: 0.413

1% critical value: 0.497

1. Observation Value 3.5916 is a Potential Outlier (Upper Tail)?

Test Statistic: 0.232

For 10% significance level, 3.5916 is not an outlier.

For 5% significance level, 3.5916 is not an outlier.

For 1% significance level, 3.5916 is not an outlier.

2. Observation Value 0.887 is a Potential Outlier (Lower Tail)?

Test Statistic: 0.128

For 10% significance level, 0.887 is not an outlier.

For 5% significance level, 0.887 is not an outlier.

For 1% significance level, 0.887 is not an outlier.