UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

Mr. John Steinert
Vice-President Hearth Products
PFS-TECO
11785 SE Hwy. 212
Suite 305
Clackamas, Oregon, 97015

12/12/2023

Dear Mr. Steinert,

I am writing in response to your emails and letter dated December 4, 2023, requesting approval of an alternative test method (ATM) for wood heater, pellet heater, and central heater demonstrating compliance with New Source Performance Standard (NSPS), 40 CFR part 60, Subpart AAA, Standards of Performance for New Residential Wood Heaters (Subpart AAA), and 40 CFR part 60, Subpart QQQQ Standards of Performance for New Residential Hydronic Heaters and Forced-Air Furnaces (Subpart QQQQ). Specifically, you have requested that we review the required dilution tunnel velocities as outlined in ASTM E2515-11 and consider alternatives with regard to determining compliance for residential wood heating appliances regulated under 40 CFR part 60. The Office of Air Quality Planning and Standards, as the delegated authority, must make the determination on any major alternatives to test methods and procedures required under 40 CFR parts 59, 60, 61, 63, and 65. Your proposed alternative test method and our approval decisions are discussed below.

Specifics of Request
You mention in your letter that ASTM E2515-11, Section 9.2.1 states the following:

> *The dilution tunnel diameter shall be sized such that the flow velocity as measured as shown in 9.3 and as established in 9.2.2 shall result in a minimum of 4.1 m/sec (800 ft/min) when the velocity pressure is measured to an accuracy of 60.025 mm (0.001 in.) water or a minimum of 7.6 m/sec (1500 ft/min) when the velocity pressure is measured to an accuracy of 60.127 mm (0.005 in.) water.*

You also note that larger tunnel diameters are necessary to handle dilution for larger volume emitting appliances such as large wood heaters, hydronic heaters and forced-air furnaces. Additionally, you state that you have concerns that the volumetric flow rate needed to meet the velocity requirement on larger diameter dilution tunnels would dilute the sample to the point that the amount of catch on a test sample could be very low, introducing a much larger source of potential error than one would expect from an appropriately accurate velocity measuring device. Being able to use slightly lower velocities, which can be accurately measured, would help offset this potential source of error. Based on the information discussed above,

you seek discretion when setting the tunnel velocity, dependent on the test conditions for each test. You also seek approval of an alternative test method allowing the use of low flow micromanometers when using ASTM E2515-11.

Additionally, you state you would also like to add adjustments as outlined below to reflect additional criteria EPA has deemed critical in other recently issued ATMs.

The following are items of found in ASTM E2515-11 you seek to be modified:

1. Section 9.2.2 – Modification of requirement:
    1. Tunnel flow rate must be sufficient to maintain tunnel temperature below 125 °F (maximum) and 104 °F on a 10-minute rolling average, excluding periods when the appliance door is open. Two exceedances are allowed of the 10-minute rolling average points in each test run.
        a. Optionally, real-time tunnel dewpoint temperature measurements recorded at a minimum rate of one reading per minute can be made to override the maximum tunnel temperature requirement (125°F maximum and I 04°F on a I 0-minute rolling average). One-minute dewpoint temperature measurements in the dilution tunnel must be below the one-minute ASTM E2515-11 filter temperature measurement. If there is an exceedance of the tunnel dewpoint temperature above the ASTM E2515-11 filter temperature, then the test run is invalid and must be repeated.
        b. As an alternative to l.a.i, the tunnel relative humidity may be measured using a psychrometer to measure the wet bulb temperature in the dilution tunnel. These measurements must be taken and recorded, at a minimum of every 2 minutes. ASTM E0377-15 Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry- Bulb Temperatures) may be followed for these purposes.

    2. Section 10.2.1 and 11.7 – Additional requirements:
        a. The filter temperature must be maintained between 80 and 90 °F during testing.
        b. Filters must be weighed in pairs to reduce weighing error propagation; see ASTM 2515-11, Section 10.2.1 Analytical Procedure. The gravimetric analysis must be done with each pair of filters, pre and post testing.
        c. Only one point is allowed outside the +/- 10 percent proportionality range per test run.
        d. Non-desiccated post-test filter weights must be taken within an hour after the post-test leak check. These initial weights must be included in the test report.
        e. Oven drying desiccation is not allowed.
        f. Dual train comparison (precision) must be calculated in terms of percent difference between the two sample trains and in terms of calculated emissions difference on a g/kg basis.
        g. Negative filter weights must be discussed in the test report. Where negative

mass (i.e. filter material left on O-rings and gaskets) is subtracted from the overall PM mass, the resultant PM mass must be reported with the mass subtracted and with the mass not subtracted for comparison purposes.

3. Section 9.5.2 to 11.4.2 – Additional requirement:
    a. Ambient background sampling and filter collection must be conducted per ASTM E2515 section 4.3 and all other method specific room air sampling requirements.

Discussion of Request and Decision

During the review of your request, the following information was also considered:
In addition to Section 9.2.1 above, ASTM E2515-11, Section 9.3.11 states:

> *"Ensure that the proper differential pressure gauge is being used for the range of Dp values encountered (see Section 6.1.5). If it is necessary to change to a more sensitive gauge, do so, and re-measure the Dp and temperature readings at each traverse point. Conduct a post-test leak-check (mandatory), as described in 9.6.5, to validate the traverse. Measure the Dp and tunnel temperature at each traverse point and record the readings."*

This clause would not be necessary to include in the test method were flow velocities always maintained at the 800 fpm or higher level, indicating to us that the ASTM committee envisioned lower flow environments necessary for some test situations where larger diameter dilution tunnels were necessary to appropriately collect and measure particulate matter (PM) emissions.

The language in ASTM E-2515, Section 9.3.11, suggests that the authors were aware that certain types of wood heaters may require the use of a larger diameter dilution tunnel which could result in velocities less than 800 ft/min, and that such a sampling situation may require the use of a more sensitive velocity measurement instrument.

For reference, a velocity measurement of 800 fpm is equivalent to a pressure differential of 0.04 inches of water, well into the useful range of a manometer capable of reading differential pressure to 0.001 inches of water as prescribed by ASTM E-2515, but at the low end of the useful range of a standard 0-10 inch inclined manometer typically used in emissions sampling. EPA Method 2, Section 16, provides reference documents that describe the use of standard (Prandtl) pitot tubes for low velocity measurements down to 3.0 fps (180 fpm)[1] as well as information on selection and use of low range manometers[2]. For your information, 180 fpm is the velocity indicated by a differential pressure reading of 0.002 inches of water, and we

1 Ower, E. and R.C. Pankhurst. The Measurement of Air Flow, 4th Ed. London, Pergamon Press. 1966.
2 Vollaro, R.F. A Survey of Commercially Available Instrumentation for the Measurement of Low-Range Gas Velocities. U.S. Environmental Protection Agency, Emission Measurement Branch, Research Triangle Park, NC. November 1976. (Unpublished Paper available upon request).

consider measurements below 0.004 inches of water (250 fpm) to be the low end of acceptability for a micromamometer capable of 0.001 inches of water resolution, therefore we recognize the need to use a more sensitive measurement gauge below that level. The use of pitot tubes for low flow measurement is a measurement area that EPA researched in the 1970's, and has been providing guidance for low flow measurement for five decades. We consider this to be sound analytical field practice and therefore, with proper micromanometer selection, such as a gauge with sensitivity to 0.0005 inches of water or lower, your velocity measurements will be on solid technical footing, per EPA Method 2, and will provide for far more sensitive low flow measurement than required in ASTM E-2515. We do not recommend the use of p-type pitot tubes for velocity readings below 0.002 inches of water for PM compliance measurement purposes from dilution tunnels as measurement uncertainty of the velocity measurement will begin to increase below this range, per the reference in footnote 1, below. Lastly, while we recognize that velocity can be appropriately measured at these low levels, we also recognize that the spirit of the test method is to provide for a higher velocity profile in the dilution tunnel, and therefore we do not expect this Alternate Test Method to be necessary for compliance tests with dilution tunnel diameters of 8'" or less.

We note that lower tunnel velocities may result in collecting PM of larger size due to sampling kinetics at the probe tip, thereby introducing an unknown amount of high bias in your emissions test result. EPA wishes to clarify that under no circumstance is it acceptable to remove any particle(s) from a filter, post-test, even if they appear to be larger than the PM 2.5 size fraction.

We also note that a dilution sampling system handling combustion gas where the flow rate is below the parameters listed in ASTM E-2515, section 9.2.1, is an indication of increased potential for the tunnel temperature to remain too high for sufficient particle formation before the sampling location is reached. A further complication of this is that warmer temperatures in the dilution tunnel are capable of carrying far more water vapor, creating a risk that condensation of water may occur within the tunnel or sampling system and this may create conditions resulting in wet filter media which would invalidate the test. With such conditions it is prudent to ensure that tunnel temperature is sufficiently low enough to maintain the dilution tunnel dew point below the temperature of the PM filter in order to avoid condensed water vapor either in the tunnel or on the filter media face, or both. Note that we consider both tunnel temperature and dew point to be of specific concern here, so that PM measurements are quality assured. In light of those concerns we are also approving your request to monitor tunnel dew point and gravimetric filter analysis procedures, per the modified sampling requirements stated above.

Based on the discussion above, with this letter we are approving your alternative test method request for the use of low flow micromanometers when using ASTM E2515-11. We find that it is acceptable to measure velocities as low as 180 fpm in a dilution tunnel using a P-type pitot tube when using a micromanometer gauge that is more sensitive than the method specified 0.001 inches of water, such as one with resolution to 0.0005 inches of water.

A copy of this letter must be included in each certification test report where this alternative test method is utilized, and a copy of the micromanometer calibration must also be included in the test report.

It is reasonable that this alternative test method approval be broadly applicable to all wood heaters subject to the requirements of 40 CFR part 60, Subpart AAA and Subpart QQQQ. For this reason, we will post this letter as ALT-155 on our website at https://www.epa.gov/emc/broadly-applicable-approved-alternative-test-methods for use by other interested parties. Please not that this alternative method approval is valid until such time that Subpart AAA and QQQQ are revised or replaced to require a different certification method, and at such time, this alternative will be reconsidered and possibly withdrawn.

If you have additional questions regarding this approval, please contact Michael Toney of my staff at 919-541-5247 or toney.mike@epa.gov.

Sincerely,

STEFFAN JOHNSON

Digitally signed by STEFFAN JOHNSON
Date: 2023.12.12 08:31:57 -05'00'

Steffan M. Johnson, Group Leader
Measurement Technology Group

cc:

Shannon Banner, EPA/OAQPS/SPPD
Lessard, Patrick, EPA/OAQPS/SPPD
Rafael Sanchez, EPA/OECA
Robert Scinta, EPA/OECA
Michael Toney, EPA/OAQPS/AQAD
Mark Turner, EPA/OAQPS/SPPD
Richard Wayland, EPA/OAQPS/AQAD