Summary of Recommendations from the PM Measurement Method Workgroup

NESCAUM

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PM Measurement Method Workgroup Charge:

To address issues specifically related to PM measurement methods included in 5G (and related methods)

Section 6 of: https://www.epa.gov/burnwise/process-developing-improved-cordwood-test-methods-wood-heaters

Workgroup Product:

List of recommendations that could improve PM measurement reproducibility (2020 NSPS Step 2 tighter limits)

5G method clean up (2017?)

Workgroup Members:

Selected by the Test Method Steering Committee

Academic Researchers with source testing expertise

Not stakeholders (S/L air agencies, EPA, commercial)

Workgroup Members:

Allen Robinson, Carnegie Mellon University

Phil Hopke, Clarkson University

Jamie Schauer, University of Wisconsin-Madison

Jay Turner, Washington University at St. Louis

John Watson, Desert Research Institute (DRI)

Workgroup Facilitator:
George Allen, NESCAUM

Workgroup Process:

1. Identified PM measurement issues that might contribute to test method reproducibility (within and across labs)

    ==> Goal was to make a ***reproducible*** PM measurement (not to make the "right" PM measurement)

2. Held four conference calls between May and September to discuss potential recommendations.

3. Reached consensus on specific recommendations
    - with ranking (1 to 3) of priority – high (1) unless noted
    - March 30, 2017 memo to test labs

⇨ These are WG recommendations, not EPA recommendations

Summary of Recommendations:

1. Water/Humidity/Temperature control in dilution tunnel and the sample train/filter:

Liquid water should not be present anywhere in the sampling system for a valid sample.

Dilution tunnel T and RH (and calculated dew point T) should be measured and logged near the sample probe

1% RH, 0.5 deg. C accuracy

Filter T should be measured and logged (0.5 deg. C accuracy)

(better than thermocouples can do)

1. (Continued) Water/Humidity/Temperature control

Limits:

Filter T between 80 and 90 deg. F (26.7 to 32.2 C)

Tunnel T not to exceed 100 deg. F (37.8 C) - priority of 2

Tunnel RH not to exceed 90%*

Tunnel dew point T at least 2 deg. C less than filter T*

* If exceeded, the test report should explicitly note the results of the sampling train liquid water inspection.

2. Filter Media:

Pallflex® Emfab™ (TX40) is recommended

Teflon coated glass fiber media

Similar filtration efficiency as glass fiber filters

Minimize interferences
- adsorbed organic and acidic gases, water vapor

3. Filter equilibration / conditioning post-sample collection:

General recommendation: use conditions and times similar to those used for the ambient PM2.5.

Do not use desiccation; equilibrate at RH between 30 and 40% for at least 24 hours.

- saturated salt solution of magnesium chloride (33% RH)

When possible, front filter mass measurements should be made soon after end of sampling ("0-day") and the next day

- to document filter mass loss over time – priority of 2

(Final filter weights would still be made as described in EPA method 5G)

4. Size-cut Cyclone:

PM10 (10 μm) size selective inlet upstream of the filter
- exclude large ash particles
- improve test consistency and precision

5. Blanks:

(1) a lab blank, which is removed from each filter batch, stored in a protective environment, and weighed during each weighing session;

(2) a loaded blank, which is placed into the filter holder, then removed, stored, and handled like a sample filter;

(3) a dynamic tunnel blank, which is run as a sample but with a particle filter over the inlet of the dilution tunnel

A room blank PM sample should also be collected during every test run (as required by ASTM 2515-11).

6. Balance Resolution:

0.01 mg resolution or better (semi-micro)
- better precision for very clean burns

The front filter should have a minimum loading of 0.20 mg for a valid test (needed for precision).

7. Filter Sample Flow Measurement:

Recommend automated volumetric flow controller
- eliminate manual flow adjustments as the filter loads

Flow rates should match what is needed by the PM10 inlet to achieve a 10 ± 0.5 micron cut-point.

8. Probe Catch:

Report sampling system catch as a separate number instead of combining it into a single mass value (to keep track of it)

(Catch is any mass from the sample probe system other than the PM on the front filter)

9. Filter Weighing Static Control:

Use an active ionizing air blower (or ^{210}Polonium alpha sources) to neutralize charge associated with the filter.

Residual charge is indicated by erratic or unstable balance readings. Ion blowers are generally thought to be more effective in removing static charge.

^{210}Polonium alpha sources must be replaced annually or more often.

10. Weigh Room Environmental Conditions:

Temperature range of 68 to 78 deg. F

RH no higher than 45%

11. Sample Flow Corrections for Water Vapor:

Corrections should be done using the average of actual tunnel dew point measurements during a sample run, rather than an assumed dew point value.

Priority of 2

12. Proportionality:

Control relationship between sample and tunnel flows to not over or under-sample different parts of the burn

(Method 5G: 8.10, 8.11, 12.7, 16.2.3)

Current 5G limits are +/- 10%

WG recommendation: +/- 5%

Note:
Constant sample flow (# 7) and proportionality:

Implies constant tunnel flow

Better measurement and control of tunnel flow?

(See #13, tunnel flow data logging)

13. Additional operational parameters to be included in a test report but not controlled for at this time:

(* indicates to logged electronically where possible)

*Pump vacuum (pressure drop across the filter)

*Filter sample volumetric flow rate

*Filter temperature

*Tunnel temperature and RH (and dew point temperature)

Filter face velocity (flow rate divided by filter's actual particle loading area)

13. Additional operational parameters to be reported (cont.)

Front filter net mass loading (mg)

Average tunnel PM concentration (mg/m^3)

***Tunnel flow rate (See #12)**

Tunnel residence time (should be in the range of 1 to 3 seconds)

Estimate of stack flow

Estimated tunnel dilution ratio range

Related Issues and Future Work.

Hot sampling (European) vs. warm (US)

Filter mass lost during equilibration:
- water and/or SVOC?
- Seek PM Workgroup input on how to assess?

Continuous tunnel PM measurements (Teom?)