

Operation and Fueling (O/F) Workgroup Meeting Notes from January 26, 2017 Teleconference

(Note: Voting Members are in bold-face)

Meeting led by **John Crouch** (HPBA, Co-Chair of O/F Workgroup) and **Lisa Rector** (NESCAUM, Co-Chair of Steering Committee)

Meeting Invitees (not necessarily all present): **Bob Lebens** (WESTAR, Co-Chair of Steering Committee), **Rod Tinnemore** (Washington) & **Phil Swartzendruber** (Puget Sound Clean Air Agency), **Marc Cohen** (Massachusetts), **Cindy Heil** (Alaska), John Wakefield (Vermont), **Lisa Herschberger** (Minnesota), Anne Jackson (Minnesota), **Randy Orr** (New York) & **John Barnes** (New York), Adam Baumgart-Getz (EPA OAQPS, Wood Heater NSPS Group Leader), Amanda Aldridge (EPA OAQPS, Wood Heater NSPS Lead), Stef Johnson (EPA OAQPS, Measurement Group Leader), Mike Toney (EPA OAQPS, Measurement Group), Bob Ferguson (Consultant to HPBA, President of Ferguson, Andors & Company), **Tom Butcher** (Brookhaven National Lab, BNL), Rebecca Trojanowski (BNL), Adam Bennett (BNL), **Gregg Achman** (Hearth & Home Technologies), **Allen Carroll** (Applied Ceramics), Rick Curkeet (Intertek), **Ben Myren** (Myren Labs), **John Voorhees** (US Stove), **Tom Morrissey** (Woodstock Soapstone), Dan Henry (5G3 Consulting), Mark Champion (Hearth Lab Solutions), John Steinert (Dirigo lab), Doug Towne (Dirigo lab), Gaetan Piedalue (Polytests lab), Jared Sorenson (OMNI lab), Sebastian Button (OMNI lab), Alex Tiegs (OMNI lab), Kelli O'Brien (ClearStak), Jeff Hallowell (Biomass Controls), Lee Mitchell (Applied Catalysts), Martin Morrill (Applied Catalysts), Jill Mozier (EPA contractor, meeting note taker)

Primary Conclusions from Meeting:

- The O/F Workgroup (WG) began discussing the 3 primary choices for defining burn rates:
 - Method 28's (M28's) four specified/fixed burn rate categories;
 - Defining burn rates as a percentage of the maximum burn rate. For example, Canadian Standard Association's (CSA's) option of defining burn rates as follows: CSA's Category 1 is < 35% of the max burn rate; Category 2 is ≥ 35% and <53%; Category 3 is 53% to 76% of max burn rate; and Category 4 is the max burn rate. It was noted that using a low burn rate defined as 35% of the max burn rate matches EPA's M28 low burn category well.
 - ASTM's method using 3 burn rate categories instead of 4, which was first used in the 2010 version of ASTM E2780. ASTM uses low, medium and high burn rates, with high burn ("high fire") being the max burn rate the stove can achieve and low burn ("low fire") being defined as follows in ASTM's method: Low Fire = minimum 8 hours burn duration but with a burn rate not to exceed 1.5 kg/h. If the model can't meet the 8 hour burn duration, the minimum burn rate must be ≤ 1.15 kg/h. So, no Low Fire Burn rate can exceed 1.5 kg/h and small stoves that can't make the 8 hours must have a Low Fire burn rate at 1.15 kg/h or less. For ASTM's low fire, the air settings have to be at their lowest setting (which is the same as in M28, except that in M28 the stove must not exceed a burn rate of 1 kg/hr). In addition, it was noted that ASTM's 40/40/20 weighting scheme for the 3 burn rates largely agrees with EPA's 4 burn rate weighting in M28.

- If the WG decides to move from 4 to 3 burn rate categories, it is important to determine what data EPA needs to bridge the gap to enable compliance determination.
- The key question the decision on burn rates hinges on is: should the test method set design parameters or should the test method challenge the unit to burn cleanly, as designed.
- There was general consensus among the WG to discuss the topic of burn rates further on the next call in February and seek to come to a decision regarding which of the 3 burn rate options (bulleted above) the proposed cordwood test method should use.

To-Do List:

- Lisa Rector will determine via e-mail with WG members if a face-to-face meeting is possible at HPBA's Expo (as an alternative to the previously discussed Tuesday meeting, which is not possible).
- WG members interested in providing suggestions for NESCAUM's proposed sampling protocol for upcoming testing by Mark Champion, regarding different operation protocols, should e-mail Lisa Rector.
- Bob Ferguson will post additional information/data to Basecamp regarding looking at the EPA database from the perspective of CSA's burn rate percentages.
- The WG should frame any remaining questions regarding burn rates in writing and post the questions to Basecamp, so that others can see and look for responses.

Highlights from Meeting:

- Lisa Rector opened the meeting and noted that the following people were in attendance: George Allen, Gregg Achman, Bob Lebens, Cindy Heil, John Voorhees, Kelli O'Brien, Gaetan Piedalue, Randy Orr, Rick Curkeet (note: Rick announced he has retired from Intertek; Rick said Lisa should reach out to Intertek if the O/F work group wants a representative from Intertek), Robert Ferguson, John Wakefield, Amanda Aldridge, Rod Tinnemore, Lisa Herschberger, as well as others who did not announce themselves.
- Lisa opened the meeting noting that the agenda for today's call includes administrative updates, a recap of the operational protocol discussion, and a discussion regarding burn rates. It will likely be a short call today. Regarding administrative updates for people attending HPBA's Expo in Atlanta, Lisa noted that the proposed meeting on Tuesday will not work, as not enough people can attend. It is not clear how many people from the States can attend the Expo, but Lisa may have a better sense of that next week. If a face-to-face meeting happens at the Expo, Lisa noted that it may happen on Thursday or Friday. Lisa will nail this down via e-mail. There were no further questions on the Expo or administrative updates.
- Lisa began recapping the operational protocol discussion from the last meeting. The O/F work group (WG) had talked about the idea of moving into integrated/composite runs rather than the hot-to-hot run in Method 28. Lisa noted that they were contemplating NESCAUM having funding to support testing at Mark Champion's lab to examine different operational protocols. Lisa is in the process of preparing a sample work plan for this, including running multiple loads at the

same burn rate and also varying operations within a single test run. Lisa asked that anyone interested in providing feedback on the sample test plan to please e-mail her with their suggestions regarding drafting the sampling protocol.

- Lisa launched the discussion regarding burn rates, that had begun during the last WG call. Lisa noted that ASTM has moved away from [Method 28's] previous definition of burn rates. Lisa put the following CSA B415 burn rates on the screen, noting that CSA 8.2.3 is the same as Method 28. **Note:** Rick Curkeet later clarified that the following CSA slide refers to year 2000 definitions [and CSA section locations] of burn categories, not the most recent 2010. In the 2010 version, there is no "5.3 or less" caveat [and these burn rate categories are located in CSA Section 7.1.4.2]. Rick further clarified that the default burn rate categories under the 2010 CSA B415 are [located in Section 7.1.3] as follows: Category 1 is < 35% of the max burn rate; Category 2 is ≥ 35% and <53%; Category 3 is 53% to 76% of max burn rate; and Category 4 is the max burn rate. Amanda confirmed that as well. Lisa apologized for her outdated slides.

CSA B415 Burn Rates

8.2.3

For appliances having a maximum burn rate at or below 5.3 kg/h, one emission test run is required in each of the following burn-rate categories (rates in kg/h dry basis):

Category 1	Category 2	Category 3	Category 4
<0.80	0.80 to 1.25	1.26 to 1.90	Maximum rate 5.3 or less

8.2.4

For appliances having a maximum burn rate above 5.3 kg/h, one emission test run is required in each of the following burn-rate categories:

Category 1	Category 2	Category 3	Category 4
<15% of maximum	15% to 24% of maximum	24 to 36% of maximum rate	Maximum rate

- Lisa noted that while [the above] are the published burn categories, Method 28's Category 1 is often below 1.0 kg/hr [rather than below 0.80 kg/hr as listed] because that's allowed as an alternative [if below 0.80 is not achievable on the stove].
- Bob Ferguson noted that origin of the 4 burn rates goes to Oregon Method 7, developed by OMNI 35 years ago, for Oregon DEQ. Bob explained that the concern then was that most people were operating their stoves at very low air settings; hence the emphasis on low burn rates. The Oregon DEQ took off followed by Colorado and that database became the basis for the original NSPS which was a regulatory-negotiation (or "reg-neg"). Bob noted that CSA B415 was just the Canadian version of M28. In 2010, CSA added central heaters (mainly warm-air furnaces) including the CSA B415 option that uses percentages of max burn rates. Bob explained that it was identified that having a prescribed fixed low burn rate pushed the designs in ways that were

only there to meet testing requirements. CSA had a different idea –that is, that the low burn rate could be a fraction of high burn rate rather than a fixed number.

- Bob continued that, the reason the >5.3 kg/hr was in the CSA regulation, was to be consistent with hydronic heater regulations. When ASTM looked into redoing M28 in 2009, there was a lot of discussion about whether 4 burn rates were necessary. ASTM ultimately determined that 3 burn rates were adequate to define performance across the range and [going to 3 burn rates] cut out an unnecessary test to reduce cost and allow an extra run. Bob noted that he has put a lot of that historical data up on Basecamp, which shows what happens when using 3 burn rates.
- Bob subsequently clarified (via e-mail to Jill Mozier) that moving from 4 to 3 burn rates happened in the 2010 version of ASTM E2780 (the updating of EPA M28) and ASTM did a lot of analysis to understand the impact of eliminating one burn rate. There was full support for moving to 3 burn rates, including from EPA at the time, according to Bob, because the extensive data analysis was quite convincing. Bob further noted that the move to 3 burn rates was tied directly to a change in the way the data is weighted. It is the combination of the two that makes it all work
- Bob continued that, in addition to getting to 3 burn rates, the ASTM method allows the use of a percentage of the max burn rate – e.g., ASTM uses 35% of high burn rate to define the low burn rate and thereby allows getting over 1 kg/hr at this low end. Bob explained that ASTM’s low burn category recognizes that for a large unit, sized right, the low burn rate will be higher than 1 kg/hr. Bob noted however that even though EPA was accepting of [this] low burn rate, the Agency was still tied into [their defined] low burn rates. Bob pointed to a paper by Dr. Houck that looked at that disconnect, and ASTM ultimately increased its minimum burn rate from 1 to 1.5 kg/hr. EPA has still been requiring a burn rate under 1 kg/hr on crib, however.
- Regarding a cordwood method, Bob noted that ASTM started thinking differently of test runs. Bob noted that he had located the mini reports from ASTM on this topic and can probably post them to Basecamp. Bob opined that it’s great that the O/F WG is looking into how to define burn rate categories again. Bob noted that ASTM’s idea for a low minimum burn rate was to allow for/represent an overnight burn rate. ASTM defined the overnight burn rate as an 8-hr burn rate – and for most stoves, that aren’t small, this is not a problem. Bob clarified that the 8-hr burn means large stoves can get an 8-hr burn with something above 1, up to 1.5 kg/hr. But ASTM recognized that some small stoves cannot meet/achieve an 8-hr burn and therefore these stoves still are required to meet a minimum of 1.15 kg/hr. Bob explained that ASTM formulated it this way because ASTM wanted to define separate definable burn rates and take away the arbitrary fixed minimum burn rate. Bob pointed out that this was sort of what CSA was doing when they used a % of the max burn rate. ASTM tried to do this as well and then took it a step further by redefining these burn rates.
- Bob subsequently clarified (via e-mail to Jill Mozier) that CSA based the burn rate categories on % of maximum burn rate without other conditions. For stoves, the minimum burn rate must be 35% or less of the maximum. So, minimum burn rates start to climb above 1.0 kg/h (the current

M28 requirement) when the maximum burn rate is above 2.86 kg/h. If the maximum burn rate is 4.0 kg/h, the model must only achieve a minimum burn rate of 1.4 kg/h or less. This does level the playing field by recognizing that larger stoves are intended to heat larger spaces and the need to force a burn rate of 1 kg/h or less is not a fair requirement. ASTM backed off the % based burn rate definitions when it was obvious that there was not consensus (at that time, at least) to move in that direction.

- Bob continued that ASTM calls it a “low fire” test and there’s a time requirement (8 hours). If the stove (e.g., some small stoves) can’t meet/achieve the time requirement of 8 hours, then there’s a burn rate limit (of 1.15 kg/hr) that must be achieved. Bob noted that the cap is 1.5 kg/hr for a stove that can burn for 8-hours; and if the stove that can’t meet the 8-hour time requirement, then the burn rate may not exceed 1.15 kg/hr for ASTM’s low fire test.
- Bob noted that there was an evolution ASTM went through – going from 4 to 3 burn rates was based on crib data and on EPA’s certified database. ASTM then moved to cordwood and redefined burn rates, but still require stoves to be tested at the maximum and minimum air settings and also at a medium burn rate – which ASTM defined as in between the max and min, but in the lower half of that range.
- To aid the discussion, Lisa put the following slides on the screen during Bob’s explanation –

ASTM High Fire

9.5 High Fire Test Category

9.5.1 Start-up Conditions – Appliance operation for the high fire test category employs a cold start. The average heater surface temperature per 9.2.2 and flue-gas temperature per 9.2.4 at the start of the test run shall be less than 10°F, (5°C) above ambient.

9.5.2 High Fire Test Primary Combustion Air Control Setting – The primary combustion air control(s) shall be at the highest setting(s) at all times during the high fire test run.

9.5.3 Other manual air control(s) shall be set at the position(s) in accordance with the manufacturer’s written instructions. Automatically operated controls shall be allowed to operate as designed.

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ASTM Draft – Low Fire

9.7 Low Fire Test Category

9.7.1 *Low Fire Test Combustion Air Control Setting* – For the low fire test run, the combustion air control(s) shall be set at the lowest airflow position and must result in a burn duration of at least 8 hours or a minimum burn rate less than or equal to 2.54 lb/h (1.15 kg/h) dry basis. The duration of the test is defined as the period of time from the beginning of the load time per 9.6.5 to the test run completion defined by 9.6.12. When the 8 h minimum burn duration criterion is used, the minimum burn rate shall not exceed 3.31 lb/h (1.5 kg/h) dry basis.

9.7.1.1 The primary combustion air control(s) shall be at the lowest setting(s) at all times during the low fire test run except as allowed by 9.6.5, 9.6.6 and 9.6.7.

9.7.1.2 Other manual air control(s) shall be set at the position(s) in accordance with the manufacturer's written instructions. Automatically operated controls shall be allowed to operate as designed.

- Regarding the above low fire slide, Bob noted that the low fire definition is close to final, but is missing one sentence from the final version. Bob clarified that ASTM's Low Fire = minimum 8 hours burn duration but with a burn rate not to exceed 1.5 kg/h. If the model can't meet the 8 hour burn duration, the minimum burn rate must be ≤ 1.15 kg/h. So, in other words, no Low Fire Burn rate can exceed 1.5 kg/h and small stoves that can't make the 8 hours must have a Low Fire burn rate at 1.15 kg/h or less. Bob noted that the air settings have to be at their lowest setting (which is the same as in M28, except that in M28 the stove must not exceed a burn rate of 1 kg/hr). Bob further noted that some stoves have secondary air controls and the ASTM method allows those to be set as the manufacturer recommends; automatic controls are also allowed to operate as recommended.
- Bob noted that ASTM had a wide variety of people and opinions on this topic and realized that they had to try to link back [any changes] to the existing database. As such, ASTM didn't want to take giant steps away from the Oregon database and what EPA was comfortable with. Therefore, Bob explained that ASTM took smaller steps along the way rather than one big step at once, because ASTM couldn't garner support of all stakeholders and of the EPA if large steps were taken.
- Lisa Rector noted that the O/F WG needs to make a decision ASAP regarding these two very different approaches [to burn rates]. In M28, the burn rates are specified/fixed. In ASTM, the high burn rate is the high air setting, the low burn rate is the low air setting, and then the medium burn rate falls in between of low and high. Bob Ferguson added that ASTM still put conditions on those general categories – that is, if the stove can't meet the 8-hr burn (with the not-to-exceed burn rate cap of 1.5 kg/hr), then the stove must not exceed a 1.15 kg/hr burn rate. In this way, it's a bridge backwards [to the existing database] too, Bob explained.

- Lisa Rector underscored, however, that the ASTM method moves from 4 to 3 burn rates and specifies test parameters rather than design parameters. So, it's a change in philosophy. Lisa noted that the WG needs to understand where the state regulators are on this philosophical discussion. Lisa observed that industry and labs are behind the ASTM method; but the WG needs to know how many states are also comfortable [with ASTM's approach] so the work can proceed. Lisa emphasized that this decision is critical in order to proceed. Lisa noted that EPA is still fairly wed to 4 burn categories. If this group recommends 3 burn rates then it's important to understand what research EPA needs, that it doesn't have already, in order for the Agency to become comfortable with 3 burn rates. Lisa asks if there was anyone in the WG who wants to stick with 4 burn rates.
- Randy Orr replied that how [the stove] tamps down needs to be captured, noting that start-up has the highest emissions and 3 burn rates might be fine. However, perhaps the dampers should be closed, not open.
- Bob Ferguson noted that the burn rate categories and the way emissions are averaged are inextricably linked. Therefore, ASTM also looked at weighting schemes and moved away from EPA's probabilistic weighting scheme, which is complicated. ASTM looked at how to weight the burn rates in its method. Bob explained that ASTM's weighting puts 80% toward the lower end of burns and that's very similar to EPA's certified stove data. ASTM's 40/40/20 weighting scheme for the 3 burn rates has a lot of agreement with EPA's 4 burn rates. Bob noted that it's important to look at the weighting of burn rates to determine how it compares to EPA's current M28 weighting. Bob reiterated that burn rates and weighting are linked. Randy Orr replied that he would think about it further.
- Lisa Rector remarked, regarding the low burn rate, the air setting should be at low air flow. Lisa noted that there's start up and then high emissions over a long time due to less than ideal burn conditions, in order to get to an 8-hour burn. Lisa further noted that moving to 3 burn categories seems to make sense and explained that NESCAUM mined [burn rate] categories 2 and 3 and found the closest alignment in those two categories. Lisa commented that something will have to be given up, but it's difficult to provide sufficient information to EPA to determine compliance. Lisa explained that EPA must be given a dataset that shows that moving from 4 to 3 burn categories is enough to determine compliance. ASTM has probably done a lot, but Lisa noted that the WG will need to speak with Stef Johnson and Mike Toney to figure out what EPA needs to be more comfortable [with 3 burn rates instead of 4].
- Bob Ferguson explained that ASTM looked at Category 1 plus 2 and Category 1 and 4 together, and all of that information/analysis is posted. The correlation between M28 and the 3 burn rates can be examined. Bob noted that this work was done 7 years ago, in conjunction with going from M28 to E2780, which was ASTM's crib method with a cordwood annex. Bob further noted that Gil [Wood of EPA] was very involved. There's a good track record and the information is there, if someone wants to re-analyze the data. Bob noted that he had already analyzed data from 100 or so stoves and, in those results, one can see that there are some differences when

you have stoves with unusual emission profiles – that is, stoves with big changes from burn rate to burn rate, a radical slope up or down. Bob explained that, for those stoves with emission profiles that are more level (less changing/radical), the weighting scheme becomes much less sensitive. Out of 140 stoves, those with changing/radical slopes from burn rate to burn rate were farthest away from equivalent numbers; but there were a whole bunch of stoves which were nearly identical. Bob concluded that the weighting doesn't matter at all for stoves with flatter emission profiles.

- Rick Curkeet noted that the CSA B415 fuel section allows for either cordwood (with specifications similar to ASTM specifications) or crib wood as an option. Rick explained that CSA B415 allows a test to be run using M28 burn rates and crib wood fuel crib, so it's compatible with the existing EPA requirements; but it also has other options using cordwood for stoves certifying only to CSA.
- Lisa Rector pointed out that there are essentially 3 choices: burn rates based on a % [of the max burn]; using 3 burn rates [as ASTM uses]; and using the 4 M28 burn rates. Rick agreed that was correct and explained that the reason 35% was chosen is that if you calculate actual percentages from EPA's database regarding what percentage low is of high, 90% of the stoves in the database have low burn rates that are between 30 and 35% of their max burn rate and the average is 31%. So, Rick concluded, using 35% of max burn rate [for the low burn rate] would match the EPA categories.
- Lisa Rector noted that she had to leave the call shortly and asked how people in the WG wanted to move forward with deciding these burn rate categories. Lisa asked if people needed more technical data to decide or if they had enough data already.
- Bob Lebens remarked that WESTAR had advocated for a low burn rate requirement in their NSPS comments, so maybe more information is needed. Bob noted that, as we try to make the test method more reflective of how units are operated, maybe we need to look again at the low burn rate. Bob wondered if it is a heat load issue and opined that these units do need to be challenged at low burn rates because that's where they are dirtiest and the controls are least effective.
- John Voorhees noted that the reason [stoves] have low burn rates is because it's required [in M28]. John wondered therefore if a stove needs to be turned down that low. John asked: If a stove can only be turned down to 1.5 [kg/hr burn rate], why does it have to be tested lower than that?
- John Wakefield pointed out that that [burn rate] may be the lowest a stove can go on a full load of wood, but it could go lower with a partial load. John asked however, why a manufacturer is forced to go lower on a full load.
- Bob Lebens noted that he was mindful of time and that this topic probably needs to be discussed in more depth, as there are a number of ways to look at this problem.

- John Voorhees agreed, noting to Lisa Rector that it should be an action item for the next call. Lisa agreed that was a great idea, noting that this issue is a key question – that is, should the test method [essentially] be setting design parameters or should the test method be challenging the unit to burn cleanly as designed. John Voorhees replied “Exactly.”
- Rod Tinnemore noted that he agreed the test method needs to move beyond the constraints that were put on. Rod further noted that he is not sure why EPA went that route but maybe stoves were highly adjustable back then. Now, however, Rod opined that stoves should not be pushed to run/burn where they can’t run/burn. Rod noted he would like the WG to discuss this issue.
- Cindy Heil also commented that she would like to talk about this topic [on the next call] as well.
- Lisa Rector asked the WG if it needed more information or if members had enough on Basecamp already to review and be prepared for the next call. Lisa asked the WG if it could discuss and decide this issue on the next call.
- John Voorhees replied that the WG should aim for both a discussion and decision on next call.
- Lisa Rector noted that she and John Crouch could outline the 3 approaches discussed on the call today and point folks where to get more information. WG members should bring their thoughts and [on the next call] a pulse of the room will be taken to see if we have consensus and can move forward.
- Bob Ferguson noted that he had additional information that is not posted to Basecamp, including looking at the EPA database from the perspective of CSA’s percentages. Bob offered to post this to Basecamp.
- Lisa Rector noted that she had to leave the call, but this discussion could continue on the WG’s next call in February.
- John Crouch noted that the WG needs to frame any remaining questions in writing. As homework over the next 7 days, John asked that WG members frame questions and post them to Basecamp in writing so that others can see and look for responses.
- Bob Ferguson noted that he could point people in the right direction, if there are very specific things that people need to see and can’t find them on Basecamp. John Crouch agreed and encouraged people to ask Bob Ferguson for specific information, as there has been an avalanche of material on this topic since 2009. So, WG members may need a guide through the material.
- Bob Lebens agreed that more discussion on this topic is needed, noting that consensus may not be reached, but it’s worth talking about more.

- John Crouch agreed to have further discussion on the topic and noted that nothing more is left on the agenda for today's call. The WG will meet in 2 weeks at noon to discuss this topic.
- Thank you to all. Meeting adjourned.