

Operation and Fueling (O/F) Workgroup Meeting Notes from May 4, 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), **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), Roger Purinton (Jotul), Jill Mozier (EPA contractor, meeting note taker)

Primary Conclusions from Meeting:

- Adam Baumgart-Getz from EPA provided a brief overview of the species testing which took place at Mark Champion's lab. The study examined PM emissions and burn rates from different species including Douglas Fir crib, White Pine crib, Red Oak crib and cordwood, Red Maple crib and cordwood, White Birch crib and cordwood, and Ash crib and cordwood. CO emissions were also measured. Study results seem to indicate that species does matter in terms of PM emissions, at least on the pre-1988 stove used in the species study (which had minimal emission control technology). Results also seem to indicate that there is not a big distinction within each species between crib and cordwood. In other words, preliminary review of results suggests that the emission differences between crib and cordwood is minimal within a species, especially compared to differences across/between species. Going forward, EPA is hoping to narrow in on 2 to 3 species and then work on the cordwood-based protocol. EPA hopes the workgroup (WG) will work with the WESTAR and NESCAUM groups on that effort before proposal, in order to inform EPA's proposal.
- It was noted that ASTM also recognized that differences between species in a wide range of specific gravity were potentially large. Therefore, ASTM prescribed a narrow specific gravity range in its cordwood method. Note: ASTM is taking final action on the current ASTM cordwood method. The method should be published within the next 6 weeks.
- It was suggested that the WG needs a face-to-face meeting to make recommendations on where to go directionally with the cordwood method. Conclusions from a core group of people experienced in data review will be presented to the larger WG after a July face-to-face meeting. Albany NY was suggested as the meeting place, with meeting space reserved in NYSERDA, 5

minutes from the airport. The suggested dates for the meeting are: to begin the afternoon of July 19th, followed by a full day on July 20th and finishing up on the morning of July 21st.

- Regarding other ongoing testing, NESCAUM received funding from Washington State a couple years ago and Lisa Rector has been overseeing running ASTM-in-a-day at Mark Champion's lab. The startup, high fire, medium and low fire draft protocol was reviewed in the March WG call. [See March notes.] TEOM results are of specific interest in current testing. Currently, 90% of the fuel is being consumed in this testing, but emissions are dropping off at 85% of the fuel load consumed. Next week (in mid-May) several people will observe the protocol in action at Mark's lab and comments will be collected. NESCAUM, via Mark's testing, is attempting to determine if the ASTM-in-a-day protocol is feasible and has merit with respect to the goals and objectives. Results of the testing to-date will be presented on the June 1st WG call.
- Other trips this summer may be feasible to view the ASTM-in-a-day protocol testing at Mark's lab, for both people experienced with lab testing and wood stove design and for people not as familiar with wood stove design and testing, although separate trips will likely be planned for these two groups.

To-Do List:

- WG members should provide comment and questions on EPA's species testing as well as NESCAUM's ASTM-in-a-day protocol and come prepared for the June 1st meeting by having reviewed data shared to-date.
- Lisa Rector will e-mail people regarding their availability and interest in attending the face-to-face meeting in Albany in July, as well as in visiting Mark Champion's lab to witness wood stove testing under the draft ASTM-in-a-day protocol.
- Lisa Rector will cancel current GoToMeetings and reschedule the WG calls as webinars, in order to allow more people on each call.

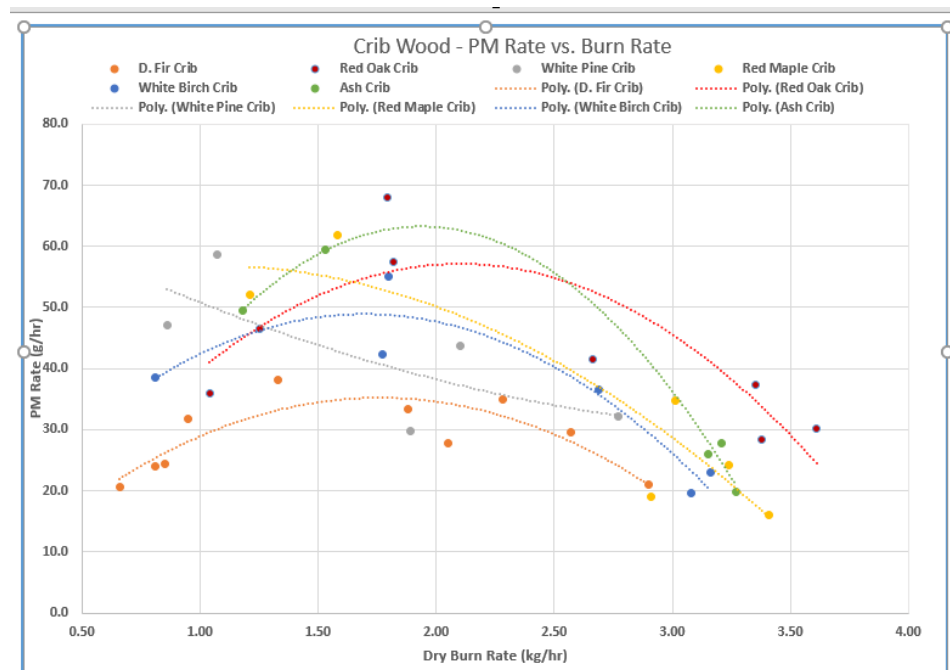
Highlights from Meeting:

- Before the meeting, Lisa Rector e-mailed four Oak and Ash PM Rate and PM Factor graphs to the workgroup (WG). John Crouch opened the WG meeting, asking everyone to look at the graphs before the meeting started.
- Lisa listed the name of the following people who were on the call, in attendance: Mark Champion, Gaetan Piedalue, Jane Gilbert, John Barnes, Gregg Achman, John Voorhees, Kelli O'Brien, Lisa Herschberger, Randy Orr, Rick Curkeet, Bob Ferguson, Sebastian Button, John Wakefield, George Allen, Rebecca Trojanowski, Tom Morrissey, Adam Baumgart-Getz, Phil Swartzendruber, Cindy Heil, Mike Toney and Jill Mozier.
- Lisa noted that it had been 6 weeks since the WG last met and that she was planning on this meeting being an update call. EPA will provide a brief overview, based on the [Oak and Ash] slides circulated, regarding the species testing at Mark Champion's lab. Lisa noted that she will

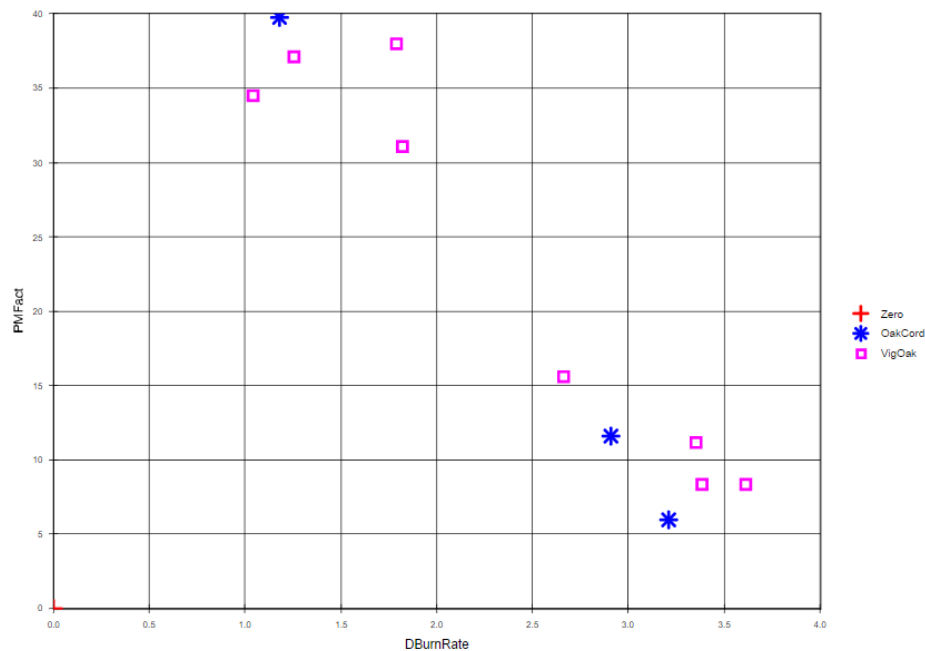
provide a brief overview of ASTM-in-a-day being funded by Washington State and also occurring at Mark Champion’s lab. Lisa further noted that she will discuss upcoming meetings, including the structure and frequency of calls for the WG. Lisa asked Adam to provide EPA’s update of the species testing.

Discussion regarding EPA’s Species Testing at Mark Champion’s Lab:

- Adam Baumgart-Getz ensured everyone had the Oak and Ash graphs, which had been e-mailed prior to the meeting. Starting with the Ash PM Factor graph, Adam noted that he hoped everyone had a chance to review the spreadsheet that Mark had sent out. Lisa put an image of the spreadsheet on the webcast screen. Adam noted that the study examined [PM emissions and burn rates from] different species [including Douglas Fir crib, White Pine crib, Red Oak crib and cordwood, Red Maple crib and cordwood, White Birch crib and cordwood, and Ash crib and cordwood]. CO emissions were also measured. Adam explained that the group [Hearthlab Solutions, SC&A (formerly EC/R) and EPA] are now doing final QA/QC on the spreadsheet of results. Adam apologized that the process has taken so long.
- Adam explained that the study began by burning crib wood first, since crib wood is used in the current standard. Adam noted that the study produced small data sets, based on a limited number of runs. Nonetheless the study found there were distinct patterns based on species. Some species’ results were closer to other species’ results, while some were distinct. But, Adam noted that the big take home message from the study is that species does matter ... at least on crib wood on an old Vigilant stove.
- Adam noted that the graph being shown to the teleconference attendees shows the PM g/hr [“PM Rate”] on different species. Adam explained that the graphs reveal a distinct pattern across species. [An example based on crib wood is shown below.]



- The next graph shows crib plus cordwood data together [the PM Factor (g/kg) versus burn rate (kg/hr) for Red Oak], which was one of PDFs sent to the WG prior to the call. In the graph being displayed for the teleconference [shown below for Red Oak], the blue stars are based on cordwood burns/runs and the pink squares on crib runs. Adam concluded that, at least on this pre-1988 Vigilant stove, there is a pattern according to species, but there is not a big distinction within each species between crib and cordwood. The emission difference between crib and cordwood is minimal within a species, especially compared to difference across/between species. Adam suggested that people look at other graphs at leisure.



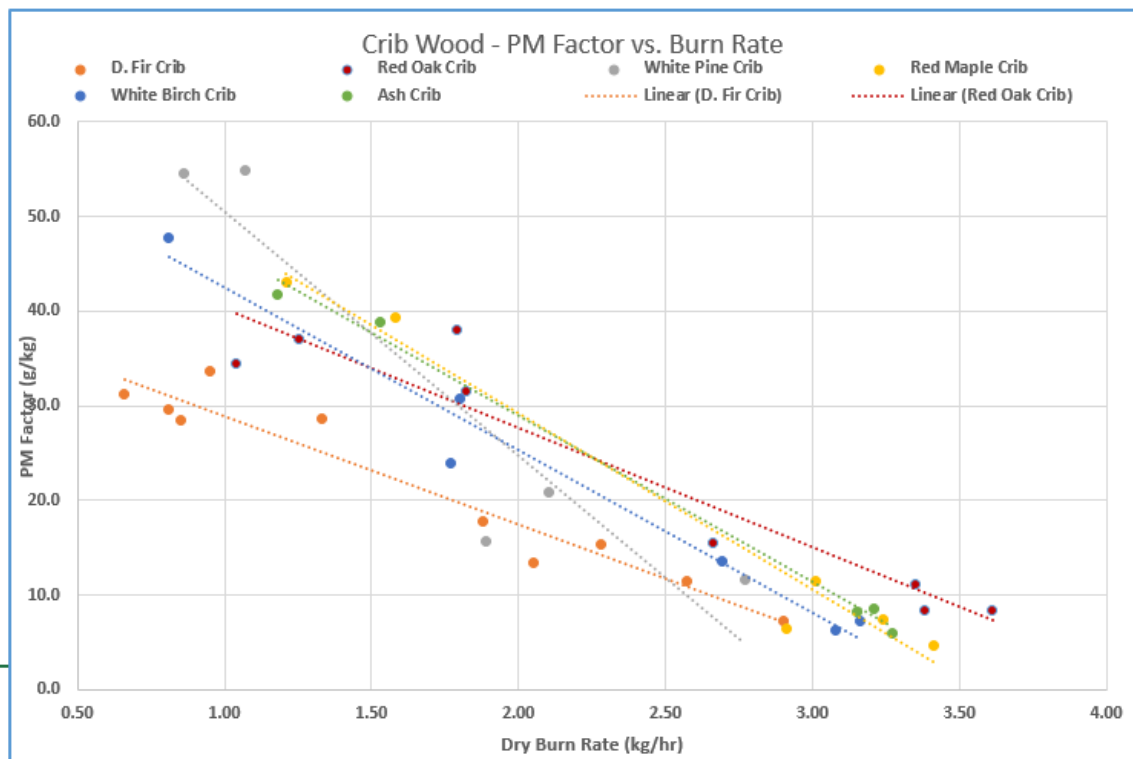
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- Adam explained that the Vigilant was chosen in an attempt to test “raw emissions” from a “campfire in a box” as much as possible. Adam noted that the study wasn’t interested in how a modern stove with different control technologies would handle emissions from various species. The goal was to determine what the raw profile for different species is and also to compare crib versus cordwood. Adam explained that EPA, through this study, is trying to build a data bridge from the crib wood standard to a cordwood test.
- Adam noted that EPA knows that not all labs can use Douglas fir cord wood [because it’s not legal to import non-native species in most states]. EPA appreciates the ASTM work, but the Agency had some indication from forestry folks that species would impact emissions. Hence EPA undertook this study, Adam explained.
- Adam explain that, at this point, EPA is hoping to narrow in on 2 to 3 species and then work on the cordwood-based protocol. Adam noted that EPA is hoping people will work with the WESTAR and NESCAUM groups on that effort before proposal. Adam explained that, once EPA

enters the proposal phase, it's very difficult for EPA to work with stakeholder decisions and recommendations directly, as the proposal work occurs behind the veil of EPA.

- Bob Ferguson pointed out that ASTM's premise was not that there is no difference [in emissions] between different species, but rather that there wouldn't be a difference under the very narrow specific gravity range [that ASTM stipulated]. Bob noted that ASTM expected similar results for that narrow range only and emissions on average were the same for two groups of woods. Adam thanked Bob for the clarification and apologized for misspeaking [about ASTM's contentions].
- Adam noted that EPA's species study at Mark Champions' lab did include the specific gravity of wood burned. Adam further noted that White Pine was thrown in there to see what a softwood would look like, but EPA didn't seriously expect White Pine to make it through the process. Adam explained that the species study looked at different species' profiles and everything else was within the range. But the most striking finding was that Douglas Fir was the outlier / most different. Adam noted however that more data needs to be collected on this.
- In response to a question from Bob regarding the g/kg [PM Factor] slide shown below, Adam noted, that there is a lot of similarity but the Douglas fir seems to be different. Adam further noted that the final numbers are on a different tab, which EPA will distribute after final QA/QC.



- Lisa Rector noted that once this spreadsheet is available, it will be posted. George Allen and Lisa will be looking at the spreadsheet closer once they receive a final dataset. Lisa noted to the WG, that she and George would love to get input on other ways to look at the data, to tease other

information from it. Lisa further noted that they would also welcome other datasets. Adam agreed, noting that EPA and HearthLab Solutions have generated this data not as a definitive answer, but as part of a conversation.

- John Crouch noted that he needs to know more what these data points mean, but it's very interesting.
- Mark Champion noted that, based on data provided in the final report, the loading densities can be determined. Mark also pointed out that the specific gravity of each species of wood is listed on the Wood Data tab. [Note: this tab indicates the following average specific gravity measured for each species: Douglas fir = 0.47; Red Oak = 0.69; White Pine = 0.33; Red Maple = 0.50; White Birch = 0.52 and Ash = 0.58].
- Adam noted that Bob Ferguson had made an excellent point about White Pine [being outside the range of specific gravity ASTM recommended] and Adam reiterated that EPA never considered having a White Pine standard. Bob added that ASTM was always concerned about the range of specific gravity. ASTM recognized that differences between species in a wide range of specific gravity were potentially large.
- In response to a question, Mark Champion replied that the damper was closed for the test batches. Bob Ferguson noted that therefore the Vigilant was not close to a campfire, because when the damper is closed, there's a convoluted flow path out to exhaust. Mark agreed, noting that this will be clarified in the final report, so that it's well understood; the test burns in the Vigilant were not that close to a campfire.
- John Crouch asked if the cribs Mark Champion made for the species testing were like those called for by Method 28. Mark replied that they were "M28-like", although were not exact because the loading density was reduced by half. Mark explained that reducing the loading density by half was done to hopefully reduce the effect of boundary conditions, in too large of a fire. Mark explained that there were two 2x4's and two 4x4's in the crib. For the cordwood tests, Mark noted that the study matched volume – that is, the wood took up the same volume with cordwood as the crib occupied in the firebox.
- John Crouch asked if the surface area of the loads was measured. Mark explained that the surface area was not measured, but he took a photo at the end of the load with a ruler, so a reviewer of the data could go back and calculate/estimate the surface area.
- Bob Ferguson reported to the WG that ASTM is taking final action on the current ASTM cordwood method. The method will be off to editors and final formalities at ASTM, so it should be published within the next 6 weeks.
- Bob further noted that the specific density [range] is the same as in the Canadian Standards Association [CSA] method and asked Rick to confirm. Rick Curkeet noted that he would look at the CSA method to be sure, as he thinks that's correct, but he may be wrong.

- Later in the meeting, Bob Ferguson noted that the specific gravity range that ASTM started with (0.6 to 0.73) covered some Oaks and Pine and even Longleaf Pine. Bob noted that some species used by Mark Champion in EPA's species testing is slightly outside of that range. Bob explained that ASTM's range comes from the Forest Service database, and are based on oven-dried wood, which may be different than how Mark determined his specific gravities. Bob noted that the ASTM range originally came from CSA's B415 method, updated for warm air furnaces. Bob concluded that ASTM's range is a narrow range of 0.13 sg.
- Lisa Rector asked people to provide input regarding the species testing results. John Crouch noted he looked forward to a final report as soon as possible.

Discussion regarding proposed face-to-face WG meeting in July in Albany:

- John Crouch discussed the possibility for a July face-to-face WG meeting with a deep data dive, noting that this idea came out of discussion in Albany in December. John noted that he will be in the East in July around the Northeast HPBA affiliate in Albany. John proposed one full day and two half-days of face-to-face WG meetings in Albany in July: that is, the afternoon of July 19th with a full day on the 20th and then finishing up on the morning of July 21st. John explained that the purpose of these meetings is to spread out and look at all the data accumulated to this point, with the expectation that a face-to-face meeting will provide for more intense brainstorming work. John noted that this is how an ASTM subcommittee meeting often works, with lots of in-person robust discussion.
- Lisa Rector noted that she does have meeting space reserved in NYSERDA, which is 5 minutes from the airport, and she also has hotel rooms blocked. Therefore, Lisa requested that people let her know if interested in attending. Lisa noted that, for regulatory folks, this will tack onto something on the Washington State work. People may want to get over to Mark Champion's lab to see some testing. During the next couple weeks Lisa and John will come up with an agenda. Lisa noted that she will provide the WG with a travel agenda soon, which will not be final, but will be final for travel purposes.
- John Crouch noted that the genesis of this meeting is an opportunity to get together and look at data. On the industry side, we are inviting people used to looking at and reviewing data. Likewise, John asked regulatory folks to invite data-oriented people to these July meetings.
- Lisa Rector noted, to put a finer point on it, the WG needs a face-to-face meeting to make recommendations on where to go directionally. The WG needs a sense regarding where the test method should be going, from a core group of folks. Then the conclusions of this core group will be presented to the larger WG after that July meeting. Lisa noted that she and John are hoping it will generate a more robust discussion. John agreed with Lisa's comments.

Discussion regarding ASTM-in-a-day testing at Mark Champion's lab:

- Lisa Rector announced that she wanted to update the WG regarding the status of the Washington State project that NESCAUM is working on. Lisa noted that NESCAUM received

funding from Washington State a couple years ago and have been running ASTM-in-a-day in Mark Champion's lab. Lisa reminded the group that, during the last call in March, she walked through the protocol, including startup and high fire with some modifications and then moving right into the medium and low fires. Lisa noted that the process at Mark's lab included that the first few runs was with different species in a medium box stove then in a larger box stove. The protocol was refined based on those runs and now Mark is performing replicate runs based on 2 different wood species.

- Lisa displayed a mock-up of the chart showing PM emission peaks of startup, high fire, medium and low fires, which also included burn rates, times, amount of wood burned, and type (species) of wood. Lisa explained that the blue line is wood burned. The red line is percent of total PM over the course of the run. Lisa noted that the study is currently at "the top of the funnel" regarding how to perform a one day protocol, that can be run multiple times in order to provide replicate runs. The final dataset, once complete, will be shared with the WG.
- Lisa noted that next week a few folks have been invited to Mark's lab to see this protocol in action during several days of testing. Comments on the protocol are being collected. Lisa noted that they are still trying to understand if this protocol has legs, that is, has merit with respect to the goals/objectives.
- Lisa explained that at this point they are keeping groups small. Lisa noted that Mark Champion will be kept busy for the next year, so that when EPA is looking to move forward with its rulemaking, the data will be available to them. Lisa noted that Mark can allow some folks in lab with advance notice. Later this summer and into the fall, Lisa explained that Mark will be burning under a different funding source and have the ability to bring other folks in to see this protocol.
- Lisa asked the WG if there is interest in early June to dig in and see the results from different runs, how to translate ASTM-in-a-day, and how to correlate back to M28. Phil Swartzendruber noted that he would be interested. Lisa asked if such a discussion should occur as an O/F WG call, noting that the discussion will require the full time available in a meeting call, once the runs are complete. Lisa explained that Mark ran M28-like tests on the stove as well as these ASTM-in-a-day protocols. Mark noted that it was about 20 runs. Lisa reiterated that, once we go through the data and discuss how to modify the protocol, the discussion will take the full time allotment.
- John Crouch opined that such a discussion should happen within this WG, rather than in a side group. The discussion will regard the snapshot of data at that point.
- Lisa noted that she and Mark would be through their QA/QC this week. Lisa further clarified that the black line is realtime PM Lisa is really most interested in the TEOM data. Lisa explained that Mark is burning to 90% [of fuel consumed], but emissions are dropping off at 85% of the fuel load consumed, at least for this stove. Lisa noted that it would be interesting to see data from the medium versus large firebox stove testing overlaid. Lisa requested that WG participants let her know what kind of data they'd like to see.

Discussion regarding upcoming WG meetings in June and July and potential lab visit:

- Lisa noted that she will plan on sharing these results during the first WG call in June, which is the first Thursday in June, June 1st. There was some discussion about having a call on May 18th as well, Lisa noted, and asked the WG if there was interest in the additional call, or if they should wait until June 1st.
- John Crouch replied that one advantage to June 1st is that the WG will be more likely to see final EPA data prior to that date, than prior to May 18th. Therefore, John suggested not having a May 18th meeting, but just having the next call on June 1st. Lisa agreed and noted that the next call is June 1st. Cindy Heil agreed as well.
- John Crouch noted that June 1st will be a data-intensive call and so the WG may want to study up beforehand. Cindy Heil noted that she wasn't able to get into GoToMeeting and would like to see data on that date.
- Lisa noted that she will change to a Webinar format instead of this GoToMeeting format, in order to alleviate the issue of people not being able to join the webcast. Lisa noted that she will therefore cancel and revise invites for joining webcast.
- Lisa noted that she and Mark Champion should touch base, given the timing of the July meeting, to see if people can come to the lab to see the test protocol being run. Mark agreed that he and Lisa should talk, as some things were still up in the air.
- Lisa requested that folks who can travel to Vermont and are interested in Mark's lab let Lisa know, so she and Mark can get a sense of how many people are interested. Mark agreed that judging interest is a good first step.
- John Crouch noted that this visit would be a lab 101 for people who don't have access to a lab and would presumably take place on that Tuesday in July. Lisa agreed, noted that if there are enough beginners, it may be best to combine those people, versus people who are expert in stove design and familiar with labs, etc. John Crouch agreed that the focus should be on people who are not knee-deep in stove design. Lisa agreed that was best for the July meeting, although on another occasion, people who are knee-deep in stove design may wish to visit Mark's lab.
- Lisa will follow-up with an e-mail to which people can answer a few questions, in order to determine who can travel to Albany in July, and also who is interested in heading to Mark's lab to witness some testing.
- Lisa thanked everyone for their attendance and noted that the WG would reconvene on June 1st.
- Meeting adjourned