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February 12, 2019

Andrew Wheeler, Acting Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington, DC 20460
Attention: Docket ID No. EPA-HQ-OAR-2018-0196

Re: Advanced Notice of Proposed Rulemaking for New Source Performance Standards for Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces

Dear Acting Administrator Wheeler:

The Northeast States for Coordinated Air Use Management (NESCAUM) offer the following comments on the U.S. Environmental Protection Agency (EPA) Advance Notice of Proposed Rulemaking (ANPRM), published on November 30, 2018, entitled *Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces* (83 FR 61585). NESCAUM is the regional association of state air pollution control agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont.[1]

<u>Overview</u>

The two guiding principles behind NESCAUM's comments are: (1) the critical need for the existing New Source Performance Standards (NSPS) to be fully implemented according to the 2015 rule schedule, and (2) the need to look to the future for continuing progress in improving the residential wood device emission control program.

Consistent with these principles, NESCAUM offers numerous suggestions to improve administrative and enforcement aspects of the current program. We also provide recommendations to strengthen the program that could be adopted and implemented as part of the next required NSPS update in 2023. These are grouped into three sections: (1) recommendations to ensure no backsliding of the current emission standards or implementation dates; (2) recommendations to enhance the effectiveness of the current rule through improved administration and enforcement; and (3) recommendations for consideration in the 2023 NSPS review.

[1] These comments reflect the majority view of NESCAUM members. Individual member states may hold some views which differ from the NESCAUM states' majority consensus.

Our comments are summarized below and detailed in the later individual sections.

<u>Summary</u>

Recommendations to Ensure No Backsliding

NESCAUM opposes any changes to the emission standards promulgated under the 2015 NSPS. There is simply no need or basis to delay or weaken the standards in light of the large body of evidence demonstrating they are technically feasible and cost-effective. Standards for all the device categories regulated by this NSPS must be implemented according to the schedule in the rule.

The 2015 NSPS provide critical public health benefits by reducing the well-documented harms caused by wood smoke exposure over the lifetime of the covered devices. Unnecessary delays in the program will result in real and lasting public health damage. Furthermore, any delay or weakening of the Step 2 standards will penalize companies that have invested in developing compliant devices and reward those that have not.

The ANPRM asks for information on the relative costs of operating cordwood and pellet stoves. NESCAUM's analysis finds that pellet stoves can be less expensive to operate than comparable cordwood units and result in fuel cost savings for consumers. Step 2 technologies promote more complete and efficient combustion, which reduces fuel use and saves consumers thousands of dollars in fuel costs over the lifetime of the device.

Existing information indicates that redesigning wood heating devices to comply with Step 2 emission standards has not generally resulted in increased retail prices. In fact, verified consumer cost data from state woodstove change-out programs show that on average, cordwood stoves with emission performance levels below the Step 2 standard of 2.0 grams per hour are priced somewhat less than those with certified emissions above 2.0 grams per hour. Many states in the Northeast provide incentives that further reduce the cost of purchasing and installing high efficiency, low emissions wood heating appliances.

NESCAUM does not support any sub-categorization scheme under the NSPS and urges EPA to maintain the current single standards for all space heating devices and for all central heaters. Establishing different emissions standards based on control technology is contrary to the fundamental construct of the NSPS program, which embodies the notion that emissions standards are established according to the best system of emission reduction (BSER), rather than on specific control technologies. If EPA decides to sub-categorize, it must provide details as to the data used to deem the current BSER analysis deficient and complete new BSER analyses for each potential category to support sub-categorization.

Recommendations to Enhance the Effectiveness of the Current Rule

NESCAUM supports keeping the existing program, as defined by the 2015 NSPS, in place. However, some administrative aspects of the program can be improved to enhance the effectiveness of the wood heater NSPS without affecting emission standards or compliance dates. By and large, our comments are directed at ensuring that program requirements are implemented and enforced according to the intent of the existing rule.

Effective compliance audit testing is needed to ensure the integrity of the emission certification process and equity among manufacturers. EPA must require that a different lab be used for audit testing than was used for certification testing to minimize biases associated with the pre-existing relationship between test facility and manufacturer. NESCAUM suggests that EPA consider using a single and independent federal lab, such as Brookhaven National Lab, for all compliance audit testing.

NESCAUM supports a strong third-party review process to ensure program integrity. To be effective, third-party reviewers need to be independent and objective. EPA must no longer allow the companies that conduct the tests to certify their own results.

NESCAUM strongly supports the use of the emissions reporting tool (ERT) to ensure timely, consistent and efficient data reporting. To meet these goals, however, EPA must ensure reporting of the full suite of information and data. We support the development of distinct test reports and certification packages for non-confidential business information (non-CBI) and those containing CBI, but EPA must clearly define what constitutes CBI and ensure that the definition is limited in scope.

EPA must retain product warranty requirements to ensure the safe and efficient operation of the wood heater devices, protect consumer rights, and promote clean burning. Current warranty requirements are too limited and do not necessarily ensure the proper operation of components that affect emissions for a reasonable period of time. NESCAUM recommends that EPA explore options for creating a more comprehensive and effective warranty program that will protect consumers and the public health from defective or worn emission control components on all devices regulated by the rule.

NESCAUM requests that EPA sunset EN303-5 as a qualified certification method for the NSPS as soon as possible, but no later than the May 2020 deadline in the rule.

EPA should adopt a requirement, to take effect immediately, for the concurrent use of a tapered element oscillating microbalance (TEOM) test method to measure real-time particulate matter (PM) during certification testing. We recommend using the NESCAUM Standard Operating Procedures.

Recommendations for Consideration in the 2023 NSPS Review

NESCAUM supports changing the way that wood heaters and central heaters are tested to make the emission certification process more representative of real-world operations than the current test methods. We provide data that highlights how current test methods are achieving real emission reductions for both space and central heaters through re-engineering to achieve BSER, which is the purpose of a NSPS. But as designs improve and units become cleaner, the current test procedures are not well equipped to serve as the basis for the certification process of the future.

In light of current BSER progress, the need for new test methods for all wood heating appliances should not be used as a rationale for creating a process that postpones full and timely implementation of the current NSPS requirements or delaying the next NSPS review. New test methods should instead be adopted as part of the next scheduled NSPS review in 2023.

A primary goal of the new test methods is to challenge a range of devices to burn cleanly under a variety of conditions that replicate in-field operations. While there has been considerable focus on changing the certification fuel, creating an effective new test method that better characterizes real-world emissions must address all aspects of the three primary components of the test procedure: (1) fueling, (2) operations, and (3) PM measurement.

NESCAUM recommends that EPA use the Integrated Duty-Cycle (IDC) approach as the platform for certification testing of all residential wood heating appliances in the future. This procedure is designed to be accurate, representative, repeatable and affordable. It incorporates emission measurements during typical operating situations, including start-up, reload, and transition across various heat output loads. The single-day test allows for replicate testing without increasing certification test costs.

NESCAUM does not believe that the ASTM or CSA cordwood test methods for heaters, furnaces and boilers, as currently designed, effectively replicates real-world conditions nor do they provide solutions for precision and variability concerns. Research conducted by NESCAUM and EPA, in fact, highlight additional precision and variability issues introduced via these methods. Consequently, NESCAUM does not endorse either ASTM 3057, 2618-13 or CSA B415.1-10 as next generation protocols.

NESCAUM would be willing to work with the Agency in using the large body of existing and on-going research and data to support and inform IDC test method and emission standard development. This approach would: (1) build on past EPA, state, industry, and test lab stakeholder discussions; (2) condense the timeframe for developing new methods and standards; (3) reduce the resource burden on EPA; and (4) provide industry with clear direction regarding the regulatory changes to anticipate and the time to begin developing the technology needed to meet standards under this new paradigm.

The following sections provide detailed comments on EPA's ANPRM.

Section 1. Recommendations to Ensure No Backsliding

NESCAUM opposes any weakening or delay in implementing the emission standards promulgated under the 2015 NSPS. The ANPRM requests input on a number of issues related to the efficacy and timing of the standards that are largely redundant to that sought in EPA's previous Notice of Proposed Rulemaking (NPRM) on *Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces* (83 FR 61574, Nov. 30, 2018). NESCAUM submitted detailed responses to these inquiries in our comments on the NPRM strongly opposing any weakening of the existing rule. Those points are summarized here, and we attach our January 14, 2019 comments on the NPRM provide a more in-depth treatment of these issues (Attachment 1).

Given the adverse health impacts associated with wood smoke exposure, any weakening of the federal program would likely promote independent state and local government action to protect public health from the emissions regulated by this NSPS. The result would be a patchwork of standards and requirements for residential wood heat devices that would increase compliance costs and complexities for regulated entities.

1.1 Feasibility of the Step 2 Compliance Date of May 15, 2020 (ANPRM Comment Area B)

Under the Clean Air Act NSPS provisions, EPA is required to review and, if improved technology has been demonstrated, revise standards every eight years. The 2015 revisions to the NSPS for residential wood burning devices were the first since 1988, even though significant technological advances had taken place over that period. No further delay in fully implementing the NSPS is acceptable or warranted. The 2020 standards are long overdue, supported by the record established in the 2015 rulemaking, and can be met today. Most manufacturers have already developed models capable of meeting the Step 2 standards.

In our comments on the NPRM, NESCAUM stated that the proposed 2-year sell-through would result in significant adverse public health impacts. For EPA's scenario 2 in the Supplemental Regulatory Impact Analysis, NESCAUM estimates foregone PM2.5 benefits of $1.9 billion to $4.4 billion. Comparing these projected lifetime foregone benefits to the additional compliance costs EPA calculates that industry would face without the relief proposed in the NPRM ($33.3 million over 3 years) results in a foregone public health benefit to industry cost ratio from 57:1 to 132:1. Any delay in implementing the Step 2 standards cannot be justified based on this cost-benefit analysis.

About 85 percent of wood stoves already met the Step 1 emission standards prior to 2015. Furthermore, our states have enforced emission standards for hydronic heaters since as early as 2007, and these state requirements are at least as stringent as the 2015 Step 1 NSPS. For the NESCAUM region, emission benefits only begin to accrue with the sale of Step 2 units.

EPA's proposed delay in enforcing the 2020 standards are largely designed to provide economic relief for regulated entities that failed to make timely investments in cleaner technologies. The existing rule already has a host of provisions that provide flexibility and accommodate industry concerns raised during the rulemaking process. Any changes to the implementation schedule would constitute a competitive penalty for those manufacturers that have made good-faith investments to develop Step 2-compliant products.

Public health and the environment should not be made to pay for poor planning and business decisions on the part of some manufacturers that have had years to prepare for this transition.

1.2 Step 2 Emission Limit for Forced-Air Furnaces (ANPRM Comment Area C)

NESCAUM opposes any weakening of the Step 2 emission standards for forced-air furnaces. Collectively, these devices are a significant source of emissions that were not regulated prior to 2015. EPA's own assessment for the 2015 rule concluded that emission standards for these furnaces constitute a highly cost-effective PM control strategy. Two manufacturers have certified units with emissions considerably below the Step 2 standards, demonstrating their technical feasibility. Hy-C Manufacturing, a small company in St Louis Missouri, has a Step 2-compliant model that will retail for under $2,000, which is similar in price to uncertified models.

Furnace heater standards have not eliminated the manufacturing or sale of any forced-air furnace models to date. Rather, manufacturers have found alternatives to the residential wood heating market to continue selling these models. While NESCAUM does not condone the practice, companies have re-purposed some models as light commercial or coal-only units. Examples of this practice are contained in Attachment 2. Consequently, any adverse economic impacts on these manufacturers has been limited and cannot be used as a rationale for not having the resources to invest in the development of cleaner burning units. EPA in its request for comments did not ask for data regarding the number of units, formerly designed for residential use, that have continued to be manufactured for the commercial market or for use with coal.

EPA requested information on the technical feasibility of installing large volumes of thermal insulation around the firebox, and whether this approach is feasible and cost effective for forced-air furnaces. While this strategy may be a reasonable option, it is not the primary source of technology transfer that should be assessed for furnaces. It is more applicable for hydronic heater applications. Wood furnaces are basically large thermostatically controlled wood stoves with fans. Technology transfer would more logically come from stoves or the non-hydronic segment of central heaters. Furnaces have a number of emission control options currently used in both hydronic heaters and stoves, such as catalysts, staged combustion, and downdraft systems. Furnaces could also use thermal sinks composed of a refractory material rather than a liquid to store heat. These common control technologies are already used across a broad variety of appliance type and sizes. To date, however, manufacturers have not chosen to deploy these technologies on furnaces.

There are also emerging control strategies such as those used by the Lamppa Kuuma furnace model, with certified emissions 40 percent below the Step 2 standard. This manufacturer employs a computer-controlled airflow system designed to promote slow fire burning in the ceramic-and-brick-lined firebox, from front to back. The fire only burns the front part of the wood as it moves up the log. Only the part burning creates heat and flame, so each piece of wood can burn longer and more completely, creating even heat in the home for the whole burn. This approach also increases efficiency, thereby reducing fuel use. While this is a proprietary technology, it demonstrates that innovative engineering solutions are available that allow forced-air furnaces to meet the Step 2 standards.[2]

1.3 Step 2 Emission Limit for Hydronic Heaters (ANPRM Comment Area D)

There is no valid rationale for changing the Step 2 emission limits for hydronic heaters. Doing so would penalize those companies that have invested in research and development to produce compliant models and reward those that have not. There are currently 11 hydronic heater models from a variety of manufacturers with tested emission levels that would enable them to certify to the Step 2 standards.

States put the industry on notice more than a decade ago that they needed to address excessive emissions from hydronic heaters. In 2007, Vermont became the first state to regulate air pollutant emissions from these devices. Ultimately, 14 states (VT, NH, ME, MA, RI, NY, MD, IN, UT, WA, NJ, AK, CO, PA) and DC adopted regulations that address emissions from hydronic heaters.

Maine has had rules in place since 2007 requiring wood-fired hydronic heaters to meet an emission standard of 0.06 lb/MMBtu where no setback requirements are in place. There are certified devices capable of meeting Maine's standard. Consequently, the industry has faced more stringent standards for these devices than required by Step 2 of the NSPS for over 10 years.

As with furnaces, hydronic heater manufacturers have re-purposed models previously intended for residential use as light commercial or coal-only units, which has minimized any adverse

[2] Information accessed from Lamppa Kuuma website https://www.lamppakuuma.com/vapor-fire-100/ screenshots from download included in Attachment 4.

economic impacts on these manufacturers. Examples are highlighted in Attachment 3. However, this practice should not be allowed to continue where it results in circumventing the NSPS for residential applications that would prolong increased PM emissions with attendant adverse public health impacts. NESCAUM provides suggestions for closing these loopholes later in our comments.

1.4 Step 2 Emission Limit for Wood Heaters (ANPRM Comment Area F)

1.4.1 Timing and Technical Feasibility

There is no technical basis to support changes to the Step 2 standards for wood heaters. The five-year period provided to manufacturers and retailers in the NSPS for selling Step 1-compliant units is more than sufficient given that in 2015, 85 percent of the stove market met the Step 1 standards and were automatically deemed certified under the NSPS. Consequently, manufacturers have been able to focus their research and development resources on designing and manufacturing Step 2-compliant models.

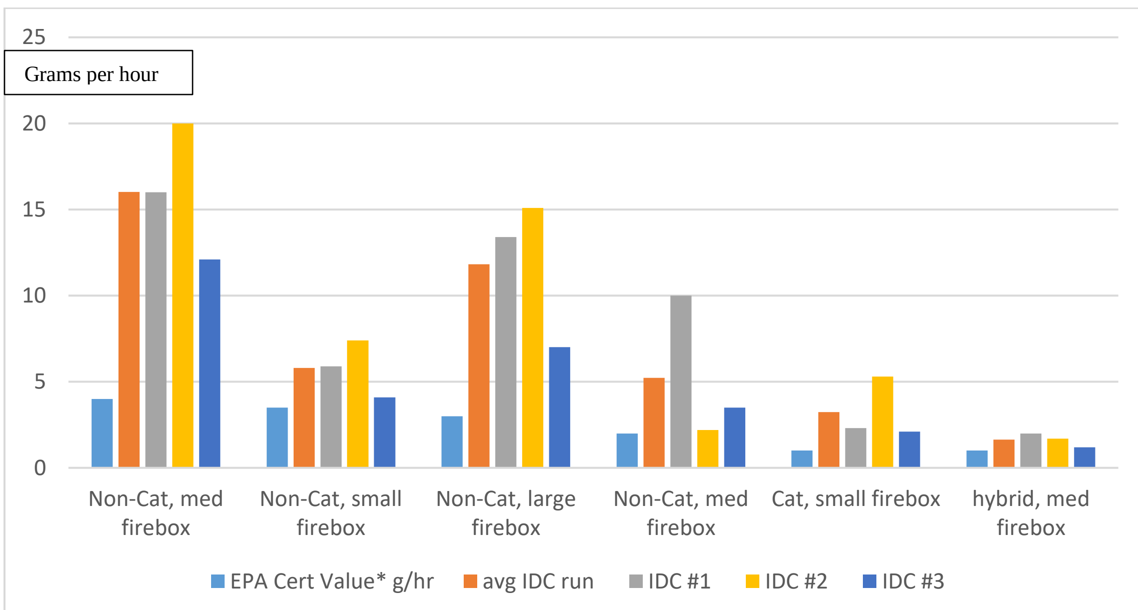
EPA's certification database from October 2018 shows that there are at least 98 Step 2-certified space heaters (56 pellet, 20 catalytic and 22 non-catalytic wood heater models), produced by 37 different manufacturers. Based on our conversations with manufacturers, many more are awaiting Step 2 certification from EPA. There are over 100 other models, from 8 additional manufacturers, listed in the database as Step 1-certified with emission levels below the Step 2 standard that have not yet gone through the certification process to qualify as Step 2-compliant. These facts clearly support the viability of the current NSPS schedule for wood heaters. The technology is widely available, most manufacturers have already built models that can comply with Step 2, and manufacturers and retailers have had sufficient time to plan for the orderly transition to 2020.

1.4.2 Efficacy of Step 2 Appliances

Ongoing NESCAUM research has shown that lower certification values translate to better emission performance and reduced variability, with a marked improvement in these results between Step 1 and Step 2 appliances. NESCAUM conducted three replicate tests mimicking typical homeowner patterns, using maple cordwood. The emissions data were then compared to the stoves' certification values. Comparing the "in-field" use patterns with certification values showed that the performance of the six stoves dramatically increased for units certified below the 2 gram per hour standard, as highlighted in Figure 1.

This testing indicates that the two Step 2 certified stoves performed with more consistency and lower emissions overall than the four Step 1 stoves with certification values ranging from 2.5 to 4.0 grams per hour. Average in-use emissions for the Step 2 stoves were 1.31 to 3.23 grams per hour. The average in-use performance for Step 1 stoves ranged from 5.23 to 16.03 grams per hour. The six models represent the broad variety of stoves available: small, medium and large firebox size, and catalytic and non-catalytic technologies. The results indicate that the Step 2 emission limits are providing real emission reductions. Step 1 stoves show broad emissions variability when tested under the same scenario as stoves meeting Step 2 emission limits. BNL and NESCAUM are in the process of completing similar research on boilers and furnaces and additional data on cordwood and pellet stoves, however, that research is still in process. When work has been completed and undergone peer review, data for these appliances will be provided to EPA.

Figure 1. Comparison of EPA Certification Values with "In-use" Protocol



**Certification values are rounded to the nearest 0.5 gram.*

The standards and schedule laid out in the 2015 NSPS are viable and will provide critical health benefits by reducing exposure to PM and other toxic air pollutants.

1.5 Operational Costs (ANPRM Comment Areas C, D, and F)

In the ANPRM, EPA suggests that there could be a considerable difference in fuel costs between operating a cordwood and pellet wood heater over the lifetime of the device. The Agency implies that if choice is limited to just pellet stoves due to the stringency of Step 2 emission standards, consumers will face higher fuel costs. This argument assumes that the Step 2 standards will limit the availability of cordwood models and that pellet fuel models are more expensive to operate than those burning cordwood. NESCAUM does not concur with either assumption.

The list of models capable of meeting Step 2 emission limits shows a broad array of both pellet and cordwood devices. Clearly, the market will offer a wide range of choices to consumers interested in both pellet and cordwood stoves.

Several variables must be considered when assessing the operational cost differential for various types of wood heaters. Costs need to be compared on the basis of delivered heat. It is widely held that efficiencies for pellet stoves are higher than for cordwood devices due to the standardized fuel characteristics and the lower moisture content in the fuel. Pellet moisture content is typically 4 to 8 percent[3] while seasoned cordwood ranges from 20-30 percent. However, wet cordwood can have moisture content as high as 66 percent.[4] Consequently, more cordwood must be burned to deliver the same amount of heat as pellets. Burning more fuel results in increased emissions and higher fueling costs.

The New Hampshire Office of Strategic Initiatives (NH OSI) monitors the retail market for residential heating fuels including distillate oil, natural gas, propane, electricity, wood pellets, and cordwood to determine the average prices for these fuels in New Hampshire. The NH OSI fuel costs tracking and reporting program shows that on a Btu basis, heating costs with cordwood ($46.72 per MMBtu) are currently twice as high as for pellets ($21.02 per MMBtu) in the state. This comparison assumes a cordwood heater with a 50 percent efficiency rating and a cord cost of $467.22.[5] The NH OSI site assumes the pellet stove is 80 percent efficient, with pellet costs of $284.50 per ton.

It is difficult to develop a generally applicable comparison of the cost of operating pellet heaters and those fueled with cordwood due to the geographic variability of fuel costs, especially for cordwood. In the Northeast, seasoned wood can range from more than $600 per cord on Long Island or Westchester County, NY to $200 in more rural northern areas. Further, less expensive log length wood can be purchased and then cut and split by the homeowner. In comparison,

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[3] Pellet Fuel Institute, "What are Pellets." Available at https://www.pelletheat.org/what-are-pellets. Accessed February 11, 2019, and included in Attachment 5.

[4] University of Tennessee Agricultural Extension Service, "W179 Wood Products Information - Moisture Content of 'Seasoned' Firewood." University of Tennessee, Knoxville; April 2010. Available at: https://trace.tennessee.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1100&cont.

[5] NH OSI – Fuel Prices website, accessed on February 4, 2019 at https://www.nh.gov/osi/energy/energy-nh/fuel-prices/index.htm. Screen shot of data is included in Attachment 6. Under the US Department of Energy State Heating Oil and Propane Program (SHOPP), NH OSI monitors residential retail prices for heating oil and propane to determine the average prices for these fuels in New Hampshire. In addition to the federal SHOPP program, OSI also monitors gasoline, diesel fuel, electricity, wood pellet, cord wood, and natural gas prices.

pellet fuel costs have been relatively consistent and stable across the Northeast for the last five years at approximately $230 per ton.

For these comments, NESCAUM performed an analysis of the fuel cost savings over an assumed 20-year lifetime of a wood device. The assumptions used are shown in Table 1.

Table 1. Assumptions for Fuel Cost Analysis

Appliance	**Fuel cost**	**Appliance Efficiency**	**Annual Btu needs**	**Transmission efficiency**
Cordwood Stove A	$250/cord	65%	25,000,000	100%
Cordwood Stove B	$250/cord	75%	25,000,000	100%
Pellet Stove	$230/ton	75%	25,000,000	100%

Based on these assumptions, a consumer who purchases a new pellet unit over a cordwood stove with 65 percent efficiency would save $242 per year or $4,840 (NPV 2019 dollars $3,710, 3% discount rate) in fuel costs over its 20-year lifetime. Since some Step 2 cordwood appliances may have efficiencies similar to pellet appliances, NESCAUM ran an analysis holding the appliance efficiencies constant at 75 percent, for the pellet and cordwood stoves. Under this scenario, the pellet stove would still yield an $83 per year cost savings for a 20-year savings of $1,660 (NPV 2019 dollars $1,270, 3% discount rate).

To assess the impact of more expensive cordwood, NESCAUM evaluated a scenario using data from the NH OIS, with costs of $285 per ton for pellets and $467.22 per cord of wood (https://www.nh.gov/osi/energy/energy-nh/fuel-prices/index.htm, accessed February 3, 2019). Assuming a cordwood stove with a 65 percent efficiency rating, a consumer buying a new pellet unit would save $1,070 annually in fuel costs or $21,400 (NPV 2019 dollars $16,400, 3% discount rate) over 20 years. Using the NH OIS fuel cost data, and assuming both appliances have 75 percent efficiency ratings, the pellet stove would still save the consumer $772 per year or $15,440 (NPV 2019 dollars $11,830, 3% discount rate) in fuel costs over its 20-year lifetime.

EPA should consider lifetime operating costs in the 2015 NSPS, including the impact of fuel savings potential associated with the increase in efficiency of Step 2 compliant units versus Step 1 units as an important social benefit of the rule, especially for the many low-income families who rely on wood heat. NESCAUM analyzed a variety of scenarios in response to this ANPRM, and in all cases, the lifetime fuel costs for pellet stoves were lower than those of cordwood appliances.

1.6 Incremental Cost for Step 2 Units (ANPRM Comment Areas C, D, and F)

Information from state change-out programs and other sources shows that redesigning wood heating devices to comply with Step 2 emission standards has not generally resulted in increased retail prices. In fact, as highlighted in Table 2, data from Vermont's woodstove change-out program show that on average, cordwood stoves with emission performance levels below 2.0 grams ($2,415) are priced somewhat less than those with certified emissions above 2.0 grams ($2,636).

Table 2. Analysis of Costs from 262 Stoves in Vermont's Change-out Program

Appliance type	Performance level (grams per hour, unless noted otherwise)	Avg verified appliance cost	Avg install cost	Avg other cost	Avg total installed cost	Appliance cost as a % of total costs	# of stoves
all stoves	2.0 or greater	$2,533	$367	$552	$3,533	72%	79
all stoves	less than 2.0	$2,573	$380	$471	$3,426	75%	183
cordwood stoves	2.0 or greater	$2,636	$367	$551	$3,533	75%	79
cordwood stoves	less than 2.0	$2,415	$380	$471	$3,331	73%	154
pellet stoves	2.0 or greater	NA	NA	NA	none	NA	0
pellet stoves	less than 2.0	$3,411	$350	$716	$4,778	71%	29
pellet boiler	Less than 0.10 lb/MMBtu	$12,184	NA	NA	$23,614	52%	134

In the Vermont program, approximately 10 percent of the incentivized stoves were pellet models (29 of the 262 stoves). The Residential Heat New York program supported the installation of 1,530 pellets stoves at a per stove price averaging $3,320 and an average installed cost of $4,450 (Table 3), which are slightly lower than those in Vermont. The Vermont data, detailed in Attachment 7, suggest that pellet stoves cost more to install than cordwood stoves. These data, however, are skewed by higher non-installation costs associated with a few models. For both pellet and cordwood stoves, average installation costs range from $350 to $380, while the site-specific "additional costs" vary widely from no cost to $2,283.

For central heater change-out programs, New York's average appliance cost was lower than Vermont's, with an average cordwood boiler cost of $10,600 and $11,700 for pellet boilers. Prices for Central Boiler Step 1 units, without installation, ranged from $7,825 to $17,165. Similarly, prices for uncertified residential units (http://www.shoproyall.com/Outdoor-Pressurized-Boiler_c_21.html) from an online retailer ranged from $6,897 to $15,249. Another online retailer (https://www.discountstoves.net/category-s/290.htm) listed both Step 1 and uncertified units for residential installations at $6,500 to $17,850. Details on these costs are found in Attachment 8. Based on the analysis and data obtained by NESCAUM, the price differential between Step 1 and Step 2 units is virtually non-existent and any difference that does exist can be recouped by fuel savings associated with the relative efficiency improvements of Step 2 models.

Data on total project costs from the Vermont and New York programs highlight the role of installation cost (Tables 2 and 3). For stoves, the cost of the appliance ranges from 71-75 percent of total costs. However, for central heating appliances, on average, the appliance cost was 39-52 percent of the total project costs. The additional costs to install an appliance will be incurred regardless of the model. The changes in Step 1 versus Step 2 costs are negligible when compared to the total project cost, especially in central heating applications.

Table 3. Residential Heat New York Appliance Cost Data

Technology	Avg. Verified Appliance Cost	Installed Costs	Appliance Cost as % of Total Costs	Total # of Projects
Step 2 Pellet Stove	$3,320	$4,450	75%	1,530
Cordwood Boiler	$10,600	$26,900	39%	36
Pellet Boiler	$11,700	$30,200	39%	51

The Vermont data provided costs for individual units based on verified receipts. These data show that prices for the same appliance types, whether Step 1 or Step 2, span a greater range than the price differential between Step 1 and 2 versions of the same models:

- HHT 4300 ACC $1,591 – $2,487
- Travis Cape Cod $3,867 – $5,342
- Vermont Casting Defiant $2,760 – $3,159
- Vermont Casting Dutch West $2,212 – $3,084
- HHT P43 $2,771 – $3,149

Incentive programs for central heating appliances in the Northeast provide purchase rebates for units with performance levels typically below 0.10 lb/MMBtu heat output. In the Vermont program, prices for residential-sized central heating appliances varied widely (138 units <200,000 Btu/hr), ranging from $4,221 to $24,412 with an average of $12,184. Costs from the New York program are similar with average pellet boiler costs of $11,700.

In assessing the economic impact of transitioning from Step 1 to Step 2 standards, EPA should take into account the generous incentives states are providing for cleaner appliances. As shown in Table 4, incentives for central heating appliances can reach as high as $21,000, while the stove incentives range from $500 to $1,500, further reducing the cost to purchase and install high efficiency, low emissions wood heating appliances. Details on these programs are found in Attachment 9.

Table 4. Northeast State Clean Unit Purchase Incentives

State	**Stove Rebate/Incentive**	**Boiler Rebate/Incentive**
Maine	$500	Up to $3,000[6]
Massachusetts	$1,000-$1,500	Up to $12,000[7]
New Hampshire	None	Up to $10,000[8]
New York	$1,500	Up to $21,000[9]
Vermont	$800-$1,000	Up to $7,000[10]

[6] Efficiency Maine, Biomass Boilers and Furnaces. Available at https://www.efficiencymaine.com/renewable-energy/about-biomass-boilers-and-furnaces/ and accessed on February 11, 2019.
[7] Massachusetts Clean Energy Center, Modern Wood Heating. Available at https://www.masscec.com/modern-wood-heating-1 and accessed on February 11, 2019.
[8] New Hampshire Public Utilities Commission, Residential Bulk-Fed Wood-Pellet Central Boilers and Furnace Rebate Program. Available at http://www.puc.nh.gov/Sustainable%20energy/renewableenergyrebates-Wp.html and accessed on February 11, 2019.
[9] New York State Energy Development and Research Authority, Renewable Heat New York. Available at https://www.nyserda.ny.gov/All-Programs/Programs/Renewable-Heat-NY and accessed on February 11, 2019.
[10] Vermont Department of Forest, Parks, and Recreation, Current Incentives and Rebates. Available at https://fpr.vermont.gov/incentives and accessed on February 11, 2019.

1.7 Sub-categorization (ANPRM Comment Areas C, D, and F)

The ANPRM solicits comments regarding the need for and potential merits of dividing wood heaters and furnaces into multiple categories with different emission standards. NESCAUM does not support sub-categorization and urges EPA to maintain the current single standards for all space heating devices and for all central heaters. Establishing standards by control technology is contrary to the fundamental construct of the NSPS program, which embodies the notion that emissions standards are based on the best system of emission reduction (BSER), rather than emissions standards based on different control technologies. Therefore, we do not support different standards based on control technology, such as catalytic versus non-catalytic controls. Sub-categorization limits technology innovation and creates more questions than it answers. For example, how would EPA regulate units that have both catalytic and non-catalytic controls? What would emission standards be for emerging technologies such as residential electrostatic precipitators or downdraft technologies that EPA does not list?

NESCAUM does not support different emission standards based on whether devices use wood pellet or cordwood fuel. These units are all burning wood for residential home heating purposes. The use of pellets should be viewed by EPA as one way to meet the BSER standard, as has been the case in other source categories. Maintaining the current construct provides industry the flexibility to determine if they will use cordwood and employ advanced control technologies or choose processed fuel as a strategy to reduce emissions.

Differentiating between cordwood and pellet units would result in more stringent standards for pellet stoves and pellet boilers, the cleanest units, and less stringent standards for the most polluting units – cordwood boilers. It would not change the stringency for cordwood stoves. Such an approach may create a bias that could increase the number for cordwood boilers at the expense of pellet-fired boilers. We also oppose different emission standards based on whether a unit is designed for indoor versus outdoor use.

The BSER analysis conducted for the 2015 rulemaking is a cordwood standard because the databases available at the time held data primarily on cordwood units, with only a limited number of pellet appliances. If EPA determines that it will sub-categorize, it must provide details about the data used to deem the current BSER analysis deficient. EPA would have to complete new BSER analyses for each potential category to support sub-categorization.

EPA's list of Step 2-certified models includes multiple catalytic, non-catalytic and pellet models, as well as indoor and outdoor models, demonstrating the viability of the current approach. As discussed later in these comments, if EPA were to make changes in a future rulemaking, then it should consider fewer, rather than more separate categories. In fact, it might make sense for EPA to use a single standard for all appliances. Ideally, a single BSER determination for all forms of residential wood heating appliances, regardless of the appliance definition, fuel burned, or control technology installed, would create a level playing field and promote greater open market competition, which would be better for consumers.

EPA should re-examine the efficiency calculation for central heating units as it applies to indoor and outdoor units. Currently, the efficiency calculation treats both units in a similar manner and fails to account for the additional transmission and jacket losses that occur with units placed outside the home and the additional distance the water needs to travel to deliver heat. Therefore, NESCAUM recommends that EPA revise efficiency calculations to include efficiency losses for outdoor installations, which occur as heated water travels from the boiler to the home through underground piping.

Section 2. Recommendations to Enhance the Effectiveness of the Current Program

EPA has requested comment on various provisions related to current enforcement and administration requirements in the residential wood-burning device NSPS program. NESCAUM supports keeping the existing program, as defined by the 2015 NSPS, in place. However, some administrative aspects of the program could be improved to enhance the effectiveness of the wood heater NSPS without affecting emission standards or compliance dates. By and large, our comments are directed at ensuring that program requirements are implemented and enforced according to the intent of the existing rule.

2.1 EPA Compliance Audit Testing (ANPRM Comment Area G)

Effective compliance audit testing is needed to ensure the integrity of the emission certification process and equity among manufacturers. This program is intended to confirm that production models available in the retail market meet the emission standards to which the prototype was certified in the laboratory. Routine testing should be conducted to assure certification labs are not “gaming” the system during the testing process. Private labs rely on the manufacturers for their business, and therefore are not necessarily disinterested in the outcome of their certification testing, especially where potential conflicts with manufacturers would threaten their economic relationships. NESCAUM offers the following recommendations to ensure a robust audit testing process.

EPA must require that a different test lab is used for the audit testing than was used for certification testing to minimize biases associated with the pre-existing relationship between a test facility and manufacturer. NESCAUM suggests that EPA consider using a single, central, independent federal lab, such as Brookhaven National Lab (BNL), for all compliance audit testing. Using different labs introduces additional variability that could be eliminated by conducting all audit testing in a single lab. Further, using an independent outside lab will not jeopardize manufacturer relationships with test labs. The audit lab should be able to oversee tests at the manufacturers' expense.

EPA has asked for comment (and information) on whether and, if so, to what degree, the Agency should consider variability when assessing the result of an audit test to determine if an appliance successfully passed. Given current technology and testing protocols, NESCAUM supports the existing EPA approach, which allows for a 50 percent margin for audit testing compared to the certification results. However, for units whose emissions are 50 percent less than the standard (e.g., <1 g/hr for space heaters and <0.05 lb/MMBtu for central heaters on all test runs), a larger margin of error may be appropriate. This variability allowance can likely be reduced with improved test procedures in the future.

2.2 ISO-accredited Third-party Review (ANPRM Comment Area H)

NESCAUM supports a strong third-party review process to ensure program integrity. Our experience has shown that there are often significant problems associated with certification testing that can be revealed through careful review of the test reports. However, the current third-party review process has generally not resulted in improved test quality, primarily because most labs are self-certifying (i.e., reviewing their own reports).

To be effective, third-party reviewers need to be independent and objective. EPA should not allow the companies that conduct the tests to certify their own results. Currently, only Poly-test and ClearStak use an independent body to conduct third-party reviews of their certification test reports. To our knowledge, all other labs - representing about 80 percent of the tests submitted - are self-certifying.

In reviewing certification test reports, NESCAUM and our member states have found significant issues with reports that have undergone third-party review, including:

- certification tests on central heaters with EPA Method 28 WHH used supply-side measurements rather than load-side measurements;
- the lack of agreement with dual train measurements; and
- subtraction of negative PM values from probe measurements.

It is our understanding that EPA expanded the geographic scope of labs to enhance testing capacity, but to date there have been no issues with long wait times to complete certification testing. Given that EPA accepts certification results from overseas laboratories, it is incumbent upon the Agency to exercise viable oversight of testing companies worldwide to assure compliance with rule requirements. EPA should require secure videotaping along with simultaneous emission data reporting such as those obtained by the Kelvin system,[11] which cost no more than $5,000 for complete installation of all software and hardware for a lab.[12] This would allow for remote witnessing of testing, demonstrate that methods had been adhered to, and provide information on tests conducted for compliance audit purposes. If EPA cannot complete compliance assurance activities on overseas labs, EPA should consider approving test labs in North America only.

2.3 Electronic Reporting Tool (ERT) (ANPRM Comment Area I)

NESCAUM strongly supports the use of the ERT to ensure timely, consistent and efficient data reporting. However, to meet these goals, EPA must ensure that the full suite of information and data are reported. Given all the different possible certification tests and alternatives, it is often difficult to know what method was performed for the certification test without access to full documentation. NESCAUM believes that EPA must require that all of the following information on certified units be provided through ERT:

- test method used;
- certification fuel;
- deviations from the method (e.g., completed two Cat 2 tests in lieu of conducting a Cat 1 and Cat 2 test, or ran extra test to eliminate or average runs);
- detailed and summary test data; and
- any instructions or information provided to the lab from the manufacturer related to conduct of the testing.

In theory, we support the development of distinct test reports and certification packages for non-confidential business information (non-CBI) and those containing CBI. However, EPA must clearly define what constitutes CBI and ensure that the definition is limited in scope.

Transparency must be maintained to ensure program integrity. States have had issues in implementing their hydronic heater rules that point to the need for EPA to clearly and narrowly define CBI. As an example, companies have supplied raw emissions data during the certification process, but claimed under CBI that states could not post the test report with some of the raw emissions data on their website. An independent review of the certification test cannot be effectively undertaken without access to the raw data. In fact, the Clean Air Act excludes emissions data from being classified as CBI (40 CFR 2.301).

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[11] "Kelvin is an industrial monitoring and control product. The Kelvin hardware/software platform that [*sic*] can be trained to monitor and control any industrial processes." *See,* https://itunes.apple.com/us/app/kelvin/id1095763235?mt=8.
[12] Data supplied by J. Hallowell, email included in Attachment 10.

NESCAUM requests that EPA clearly delineate what cannot be considered CBI and explicitly state that emissions data cannot be designated as CBI. Vermont updated its statute regarding CBI for hydronic heaters as follows to maximize transparency:

> *(a) Confidential records. The Secretary shall not withhold emissions data and emission monitoring data from public inspection or review. The Secretary shall keep confidential any record or other information furnished to or obtained by the Secretary concerning an air contaminant source, other than emissions data and emission monitoring data, that qualifies as a trade secret pursuant to 1 V.S.A. § 317(c)(9).*

We direct EPA to Attachment 11, MassDEP *Guidance on Requests to Maintain Trade Secret Information Confidential*, as a model guideline for companies filing information through the ERT that they wish to be kept confidential and exempt from public disclosure as trade secrets.

2.4 Warranty Requirements for Certified Appliances (ANPRM Comment Area J)

EPA must retain warranty requirements to ensure the safe and efficient operation of wood heater devices, protect consumer rights, and promote clean burning. The residential wood burning device rule must include warranty requirements for manufacturers that ensure the proper operation of components that affect emissions for a reasonable period of time. Currently, these warranty requirements apply only to catalysts on devices that employ this technology, and they are quite limited in coverage. The warranty program under the existing NSPS does not cover emission-related components on non-catalytic devices, although some manufacturers do. NESCAUM recommends that EPA explore options for creating a more comprehensive and effective warranty program that will protect consumers and the public health from malfunctioning emission control components on all devices regulated by the rule.

While there are clear differences in terms of how consumers service automobiles compared to wood heaters, EPA's federal motor vehicle emission control program offers some approaches that may make sense for the wood heater industry. For example, the Federal Emission Performance Warranty covers multiple emission-related components for a period of 2 years or 24,000 miles. Critical emission control components, including catalysts and on-board diagnostic systems, are covered for 8 years or 80,000 miles. These requirements provide free service and replacement of worn or defective parts.

Warranty requirements in the 2015 NSPS oblige owners to operate wood heating devices consistent with the owner's manual. Owner's manuals, however, are often confusing and provide conflicting information to consumers to conform with rule requirements. Some manuals describe two methods of operation: one based on certification testing as required by the rule, and another that is different and inconsistent based on how a manufacturer thinks the device should be used. EPA must not allow the latter. Attachment 12 provides an example of a manual with conflicting operational guidance on page 8, where it states that a full load is 125 pounds of wood versus page 20 where it states, "125 pounds is sufficient for an 8-hour burn, a full load is loading the unit to within one inch of the top of the door." Loading of this unit indicates that this could be at least 50 percent more wood by weight than 125 pounds.

NESCAUM recommends that EPA retain warranty requirements for elements that impact emissions performance and eliminate warranty requirements that fall outside this realm. It should be noted that EPA has provided manufacturers with the option to deviate from certain program requirements by requiring components within the owner's manual. If EPA exempts the owner's manual or warranty requirements, it must put in place other requirements to ensure compliance assurance can be completed.

2.5 Ending the Use of EN303-5 as a Certification Method (ANPRM Comment Area A)

NESCAUM requests that EPA sunset EN303-5 as a qualified certification method for the NSPS as soon as possible, but no later than the May 2020 deadline in the rule. We concur with Intertek's statement that, "There is a significant amount of concern regarding the inclusion of EN 303-5 as an acceptable emissions measurement test method since the procedures are vastly different than the ASTM and the EPA methods and there is no correlation or equivalency between these methods."[13] EN303-5 uses an entirely different PM measurement, fueling, and operational protocol to assess performance. We concur with HPBA statements in 2015, contained in Attachment 13, that the data show EN303-5 only measures 10 percent of emissions, compared with EPA M28WHH.[14]

In addition to the lack of comparability between the EN303-5 method and M28WHH, we also have concerns about the ability to conduct compliance assurance measures with units tested by EN303-5. This method includes none of the requirements contained in 40 CFR § 60.5473 to conduct a valid test. We have not been able to identify any EPA-certified labs that can conduct EN testing. The EN303-5 method also does not contain any prohibitions against manufacturer involvement in testing and storage requirements (as detailed in Section 60.5475(b)(8)). We are unaware of any EN303-5 unit complying with the provisions of section 60.5475(b)(10), which requires, "A statement that the manufacturer

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[13] Curkeet, R, "New Hearth Emission Standards: The Definitive Guide to the EPA's New Source Performance Standards for New Wood Heaters." Page 5, Intertek. Available at: http://www.rumford.com/woodburningregulation/CurkeetGuideTo2015EPAHearthEmissions.pdf.

[14] Hearth, Patio and Barbecue Association, "HPBA's Comments on EPA's Proposed New Source Performance Standards (NSPS) for Residential Wood Heaters. Attachment 17 Comparison of EN303-5 & EPA Method 28 WHH Results From a WHH Tested to Both Methods" May 2, 2014. Available at: https://www.hpba.org/Portals/26/Documents/Government%20Affairs/NSPS%20Members/HPBA%202014%20NSPS/Attachment17CentralBoilerComparisonofEN303EPAM28WHHResultsApr222014.PDF?ver=2016-11-21-105529-150.

has entered into contracts with an approved laboratory and an approved third-party certifier that satisfy the requirements of paragraph (f) of this section."

2.6 Multi-Fuel Units (ANPRM Comment Area A)

Currently, there are several appliances that are advertised to burn a variety of fuels. The requirements for units that do not burn wood are clear. On the other hand, the requirements for dual-fuel units that can burn wood and other fuels are not clearly articulated in the final rule language. EPA's intent, however, is clearly described on page 72 of EPA's response to comments for the 2015 rulemaking:

> *This final rule does not include any requirements on alternatively fueled devices, such as those fired solely by coal, gas, corn or oil. This NSPS is specific to wood-fueled devices, including certified pellet-fuel fired devices. We are not setting emission standards for coal-only or corn-only stoves at this time because we do not have good fine particle emission performance data for these stoves. Such stoves will need to be labeled that they are not approved under the wood heater standard and that it is illegal to operate them with wood* ***. This rule does apply to dual-fuel appliances that have been designed and approved to burn both wood and another fuel (e.g., coal, corn, gas, oil)*** *, however. Dual-fuel stoves would be required to be certified under this rule by passing the particulate limit when burning wood. For example* ***, if a manufacturer wants to label a stove capable of burning both wood and corn pellets, the stove would have to be tested using each fuel type. Both results would have to be reported*** *, but it would only be subject to the PM standard for the wood fuel. It should also be noted that, while the rule does not apply to non-wood burning appliances, this exemption does not mean these stoves (e.g., coal-only) have low fine particle pollution, particularly if they are burning low-quality coal or something other than coal, such as wet wood, trash or debris.* (emphasis added)

State regulatory agencies have attempted to obtain test data for non-wood fuels from manufacturers of multi-fuel units. To date, they have not supplied emissions data for any fuel other than wood. We urge EPA to clarify testing requirements to include regulatory language reflecting EPA's intent presented above that multi-fuel units designed to burn wood must conduct and report testing for the non-wood fuels.

2.7 PM Measurement Requirements for Improvements in Method 5 G and ASTM 2515 (ANPRM Comment Area A)

EPA should adopt a requirement, to take effect immediately, for the concurrent use of a tapered element oscillating microbalance (TEOM) test method to measure real-time PM. We recommend using the NESCAUM Standard Operating Procedures (available at https://www.nescaum.org/topics/test-methods/test-methods and included in Attachment 14), along with standard filter measurements for all EPA residential wood heating device NSPS certification testing, including pre-burn activities. For all testing, a complete real-time emission profile should be submitted as part of the non-CBI portion of the test report.

2.8 Compliance Assurance and Transparency (ANPRM Comment Areas A and I)

Under the 2015 NSPS, EPA put in place new requirements to provide transparency and access to data in support of compliance assurance activities. To date, states and other agencies have experienced significant issues in obtaining data for basic compliance assurance elements, such as 30-day notice requirements, 60-day post-test tracking and reporting requirements of non-CBI data such as emissions testing results, annual sales, and final certification test reports.

Additionally, EPA has left it to manufacturers to post their own certification tests rather than creating a central space on an EPA site to compile these results. Without a central depository, finding these tests is a difficult and time-consuming task. NESCAUM urges EPA to ensure that all compliance reporting requirements specified in the 2015 NSPS are implemented and the states and public are provided easy access to these data. The current approach fails to provide sufficient transparency for effective oversight and compliance monitoring.

2.9 Appliance Applicability (ANPRM Comment Areas C, D, and F)

Since the 2015 NSPS was promulgated, stove, hydronic heater, and forced-air furnace manufacturers have re-purposed their wood-burning residential models to new uses or fuels, such as “light commercial” or “residential coal-only” units. These models, however, are the exact same models that were previously offered as residential wood units, as shown in Attachment 15.

EPA should close this loophole, which allows high emitting models to continue to be sold in circumvention of the purpose of the NSPS. EPA should define a size threshold and require that any unit sold as a solid fuel appliance must meet NSPS standards, regardless of where it is sited or the type of fuel it is advertised to burn. We propose a size threshold defined as any unit smaller than 1,000,000 Btu/hr regardless of installation location. This would be consistent with current state regulations, such as those in Massachusetts, New York, Rhode Island, and Connecticut, which use this threshold for solid fuel-fired boilers. Finally, EPA must review all manufacturer claims of residential solid fuel appliances to determine if they are indeed exempt, rather than uncritically relying on the manufacturers’ self-determinations. Assessments to determine if appliances qualify for an exemption should include at a minimum previous sale as a wood heating device and review of Underwriter Laboratory (UL) certification for use as a wood heater for safety testing purposes.

Section 3. Recommendations 2023 NSPS Required Review (ANPRM Comment Area A)

EPA has long been aware that federal certification methods for residential wood heaters are not representative of real world” use, as it was one of the conclusions in EPA’s 1998 technology review.[15] Industry, states and EPA are all on record supporting changes to the way that wood heat devices are tested to make the emission certification process more representative of real-world emissions than the current test method. However, "real-world" use is not simple to define nor is there a single correct answer. While we strongly agree this sector would benefit in the future from new test methods, NESCAUM does not support any delay in implementing Step 2 standards while new test methods are being developed.

Results from NESCAUM's ongoing research demonstrate that the current test methods are promoting real emission reductions for both space and central heaters through re-engineering to achieve BSER, which is the purpose of the NSPS. But as designs improve and units become cleaner, the current test procedures are not well equipped to serve as the basis for the certification process of the future. According to EPA, "the fueling and operating test methods prescribed by the 2015 NSPS represent a step in the process toward better test methods, rather than the end goal."[16]

Test methods development is complex and requires significant investment in data gathering and analysis to inform new protocols. The New York State Energy Research and Development Authority (NYSERDA) has invested over five million dollars developing new test methods to assess the performance of residential wood heating devices, with work still ongoing. This work is based on the direction provided by EPA in their 2016 Discussion Paper on Cordwood test methods, "the goal of robust new test methods should be to assess an appliance's ability to operate cleanly under highly variable conditions, both in terms of fueling and operations."[17] Based on NESCAUM's experience assisting NYSERDA with protocol development, we recognize the significant investment EPA must commit to in terms of staff time and resources. We recommend that EPA begin work on revised test methods immediately to ensure their availability for the next update of the residential wood heater NSPS which is required to undergo review in 2023.

EPA has already acknowledged (Attachment 16) that even with an "aggressive schedule,"[18] new test methods would not be completed prior to the next mandated NSPS review in 2023, under its currently proposed approach. Revised test methods will require additional rulemakings with new BSER standards, a process that would likely take another two to three years. With industry's call for at least a five-year lead-time to design, prepare, and test to the new method, it is unlikely that

[15] McCrillis, R. "Residential Wood Combustion Technology Review Volume 1. Technical Report - EPA-600/R-98-174a." Page 34, December 1998. Available at: https://www3.epa.gov/ttnchie1/ap42/ch01/related/woodstove.pdf.
[16] US EPA Office Air Quality Planning and Standards, "Process for Developing Improved Cordwood Test Methods for Wood Heaters." Page 7, March 2016.
[17] Ibid, page 1.
[18] Email correspondence with C. French and S. Johnson, US EPA OAQPS. December 2018 transcript provided in Attachment 16.

new standards for all devices could be put in place before 2030 under the EPA-proposed test method scenario detailed in the ANPRM. State and local agencies cannot wait another decade for improved emission performance.

The need for new test method changes for wood heaters and central heating devices should not be used as a rationale for creating a process that postpones full and timely implementation of the current NSPS requirements or delaying the next NSPS review. Sufficient resources must be devoted to this work now, so that EPA is prepared to move forward with these changes concurrent with the next NSPS revision. If EPA moves in the direction of the Integrated Duty-Cycle (IDC) test methods for all residential wood heating appliances in the future, as the NESCAUM states support, the timeline to a new method could be shortened considerably based on the discussions and agreements already reached. States committed fully to the process EPA laid out in their 2016 Discussion Paper, included in Attachment 17. The commitment to that process is clearly shown in the EPA notes from the stakeholder discussions about the IDC development process included in Attachment 18 and NESCAUM's effort to secure resources to support the research and facilitation of the test method development process.

NESCAUM would be willing to work with EPA to use the large body of existing and emerging research and data to support and inform test method and emission standard development. This approach would: (1) build on the 2016 – 2017 stakeholder process; (2) condense the timeframe for developing new methods and standards; (3) reduce the resource burden on EPA; and (4) provide industry with clear direction regarding the regulatory changes to anticipate, and the time to begin developing the technology needed to meet standards under this new paradigm.

NESCAUM understands the likelihood that different numerical emission standards may be justified as a consequence of significant changes to test methods. EPA should be working with industry and states during the period leading up to 2023 to gather data that will inform BSER standards under a revised testing regime. It is incumbent upon EPA to perform new BSER analyses based on representative data for U.S. appliances tested with these methods to support revised emission standards. Additionally, under any new BSER analysis, EPA must expand its standards to include carbon monoxide and efficiency, as sufficient data will be available to support those standards based on the data reporting requirements for carbon monoxide and efficiency contained in the 2015 NSPS.

For wood heaters, EPA has deemed ASTM 3053-17 as a broadly applicable cordwood test method. Review of certification tests that have been conducted with this method, however, show that it shares many of the flaws of current test methods, and introduces new issues. Moving from

M28R[19] (or its equivalent ASTM 2780) with cribs to ASTM 3053-17 with cordwood will not sufficiently improve correlation with field results, as this method fails to address key issues, which are discussed in detail below.

NESCAUM urges EPA to adopt the IDC approach as an Alternative Test Method (ATM) under the current NSPS. We anticipate finalized IDC methods for stoves, furnaces, and boilers by late spring 2019, with variability and precision data completed by the end of 2019. This would enable and promote manufacturers' efforts to evaluate the emission impacts of engineering changes under a variety of testing approaches. The results of this testing would allow EPA to begin to evaluate BSER and inform the development of appropriate emission standards in preparation for the 2023 NSPS update. Further, if data accompanying these revised tests provides a basis to use correction factors to translate emission results to the 2015 Step 2 emission standards, EPA should allow their use to encourage data acquisition during the transition period.

With an eye toward the next revision of the NSPS, NESCAUM offers a number of specific suggestions to improve the emission control program for residential wood burning devices.

3.1 Overarching Test Method Elements (ANPRM Comment Area A)

A primary goal of the new test methods is to challenge a range of devices to achieve a clean burn under a variety of conditions that closely replicate in-field operations. While there has been considerable focus on changing the certification fuel, an effective new test method that better characterizes real-world emissions must address all aspects of the three primary components of the test procedure: (1) fueling, (2) operations, and (3) PM measurement, as EPA indicates in its 2016 paper.[20] EPA's inquiries have focused primarily on cordwood testing for stoves; however, significant issues with ASTM cordwood boiler methods and CSA cordwood furnace methods also exist.

3.1.1 Fueling Protocol

A test method that simply changes from dimensional lumber to cordwood will not yield major improvements, as highlighted in Figure 2. In fact, results from EPA's 'Vigilant' study, included in Attachment 19, "suggests to some in the experimental design group that differences in PM

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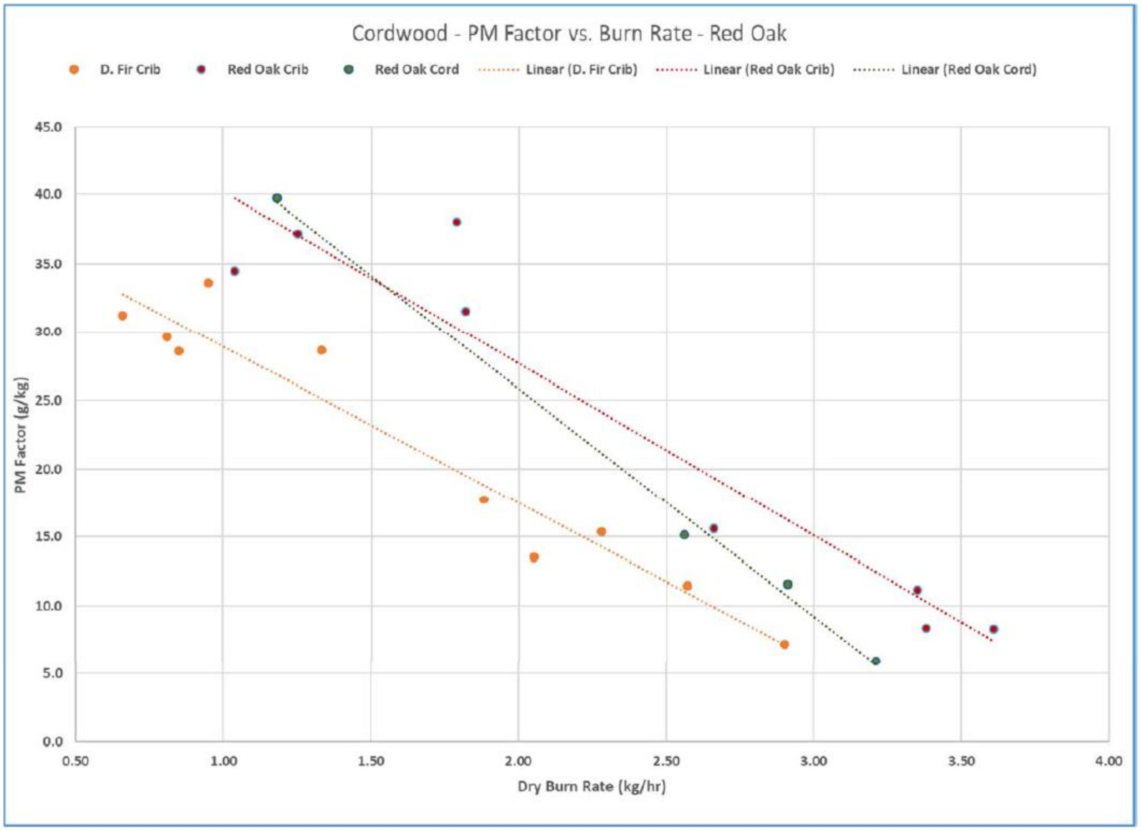
[19] US EPA, Method 28R - Certification and Auditing of Wood Heaters. August 4, 2017. Available at: https://www.epa.gov/sites/production/files/2017-08/documents/method_28.pdf.
[20] US EPA Office Air Quality Planning and Standards, "Process for Developing Improved Cordwood Test Methods for Wood Heaters." Section 6, March 2016.

emissions and burn rates are greater between species than between crib wood and cordwood in the same species"[21]

Figure 2. EPA Study Comparing Emission Factors from Crib and Cordwood[22]



The photos of Figures 3, 4, and 5 come from certification testing using the ASTM cordwood method and illustrate that the ASTM method allows the manufacturer to specify wood dimensions, configurations and spacing that are not representative of "in-use" field practices. The pieces more closely resemble symmetric crib wood test beds than a homeowner's typical less-structured loading.

Thirty-day notice certifications indicate that a number of stoves completed certifications with both M28R cribs and ASTM cordwood testing, as indicated in Attachment 20; however, only the ASTM cordwood data has been made available. We urge EPA to follow rule requirements laid out in 40CFR 60.537(f) and 60.5479(f), and require manufacturers to share this data so an

[21] Cole, D., "Final Report: Wood Species Testing Using Crib and Cordwood in a Pre-NSPS Residential Wood Heater." Page 12, US EPA, March 4, 2017. Prepared under EPA Contract No. EP-D-12-001Work Assignment #4-08.

[22] Ibid.

independent assessment of the comparative performance of ASTM Method 3053-17 and M28R (or ASTM 2780) can be completed.

Figure 3. Photo from ASTM Certification Test[23]

Figure 4. Cordwood Fuel Load for Certification Test[24]

Run 3 – Test Fuel Load

[23] Sendelbeck, B., "First Wood Stove Certified to EPA's Cordwood Standard," Hearth and Home Magazine, June 16, 2017. Available at https://www.hearthandhome.com/news/2017-06-16/first_wood_stove_certified_to_epa%E2%80%99s_cordwood_standard.html

[24] Omni Test Labs, "Non-Confidential Business Information (Non-CBI) Certification Test Report Travis Industries, Inc. Model: Large Flush Wood Hybrid Fyre Insert, June 2018. Available at https://www.lopistoves.com/TravisDocs/EPA/EPA%20Report%20Large%20Flush%20Wood.pdf.

Figure 5. Cordwood Fuel Load for Certification Test Large Evergreen Stove – Travis Industries[25]

Run 3 – Test Fuel Load **Run 3 – Test Fuel Load In Stove**

Similar fueling issues are found in ASTM 2618-13 (cordwood boiler protocol) and CSA B415.1-10 (cordwood furnace protocol). Replicate testing conducted under a NYSERDA study using the CSA B415.1-10 fueling protocol found significant issues with reproducibility. NESCAUM will make these data available to EPA and other stakeholders upon completion of NYSERDA's peer review process, which will occur after the ANPRM comment deadline.

Both methods also allow significant modifications to the fueling protocol via the use of manufacturer's instructions to the lab. While no single fueling protocol can be representative of all field operations, a key to obtaining comparable field performance to certification values is ensuring that the appliance will operate well with different piece spacing and sizes. All current Federal Reference Methods (FRMs) and ATMs allow for the manufacturer to specify spacing. Attachment 21 provides examples of manufacturer instructions for fueling and operation used in conducting certification tests with the broadly applicable ATM that mandate specific piece size, placement and spacing. This approach results in data that do not provide adequate information to assess how well a unit will perform when fuel is not placed in the same patterns.

[25] Omni Test Labs, "Non-Confidential Business Information (Non-CBI) Certification Test Report Travis Industries, Inc. Model: Evergreen." October 2018. Available at https://www.lopistoves.com/TravisDocs/EPA/EPA%20Report%20Evergreen.pdf.

NESCAUM supports a comprehensive revision to the fueling protocols for revised test methods. In addition to using cordwood as the test fuel, the test procedure of the future must address all of the following key elements.

3.1.1.2 Piece Size

Research shows that the choice between large or small wood pieces significantly impacts emissions. NESCAUM believes that it is best to include a mix of piece sizes and configurations in the testing protocol. As part of the IDC method, NESCAUM and BNL have developed a fuel calculator to determine appropriate parameters for different stoves. Working drafts of the fueling protocol can be found online at: https://www.nescaum.org/topics/test-methods/test-methods. This method recognizes that fuel use is affected by the size of the firebox, and that fuel lengths are based on typical commercial lengths. The calculator inputs key variables, such as overall firebox volume, appliance length, and fuel density, to scale piece sizes appropriately. This approach allows different models to be tested in the lab in ways that more closely resemble how they will be fueled in homes. The IDC methods also includes variable load configurations, which challenge the unit to operate effectively with different sized pieces of wood.

3.1.1.3 Fuel load

Variation in the number of pieces loaded, the loading arrangement and the size of the coal bed is required to determine how the unit will work under the variable loading conditions it will experience in the field. An EPA study suggests that the wood load amount has a more significant effect on PM emission rates (not necessarily emission factors) than burn rate.[26] This is because the higher stack flow values at higher burn rates (which have lower g/kg PM emission factors) and the lower stack flow values at lower burn rates (which have higher g/kg PM emission factors) tend to counterbalance each other with respect to grams per hour PM emission rates.

The recommended fueling procedures in the ASTM method perpetuate industry's unrealistic assumptions about the amount of wood that actual users load into their woodstoves. Studies as far back as the 1980's have shown that industry significantly overstates the batch size used in actual practice. In 1985, the Oregon Department of Environmental Quality (DEQ) conducted a study to better understand how much wood users typically load into their stove. The DEQ had been assuming 7 pounds of wood per cubic foot of volume in the firebox. At that time, industry asserted it should be 17 lb/ft^3. A detailed study of nine homes found an average load factor of 5.4

[26] Leese, K.E. and Harkins, S.M. Effects of Burn Rate, Wood Species, Moisture Content and Weight of Wood Loaded on Woodstove Emissions, prepared for the U.S. Environmental Protection Agency by Research Triangle Institute, Research Triangle Park, NC. EPA-600/2-89-025. 1989.

lb/ft^3.[27] Nevertheless, a recent manufacturer's test report for a wood stove tested with the ASTM method indicated an initial load of 17.5 pounds of wood in a firebox with a volume of 1.44 cubic feet.[28] Using unreasonably large batches and requiring that they burn back to the original weight extends the testing time and the charcoal tail portion of the test. This allows appliances tested with a gram per hour standard to average emissions over a long period during which a large portion of the time is the "tail" with lower emissions. At the smaller loads commonly used in actual practice, this extended low emissions tail does not exist. A lab test using this protocol inappropriately indicates the device emits at a lower rate than it will in the field.

Research conducted by NESCAUM on Method 28R tests shows that, on average, 100 percent of the wood is consumed when 52 percent of the testing time has elapsed, with no emissions or emissions loss occurring for the remainder of the testing period. Four of the six tests in the research program showed that 90 percent of measured PM emissions occurred in the first hour after the fuel load was placed on the hot coals. Real-time measurement data suggest that the long charcoal tail minimizes emission peaks and creates precision issues by promoting conditions that encourage volatilization of PM on the filter. Table 5 highlights the amount of time that the real-time measurement method (based on 15 second averages) found negative PM results. Real-time PM data for all Method 28R runs, highlighting the PM loss, is included in Attachment 22.

Table 5. Analysis of PM Measurement for 18 M28R Test Runs

Stove #	M28R test run	Mins 100% PM	% of test time to 100% PM	Mins to burn 90% load	Mins to burn 100% load	Mins with Neg PM Y/N(=#min)
1	Low	108	33%	216	328	Y (215 min)
	Medium	106	40%	168	262	Y (165 min)
	High	45	37%	90	122	Y (73 min)
2	Low	89	45%	137	199	Y (105 min)
	Medium	74	37%	135	198	Y (123 min)
	High	67	43%	112	156	Y (92 min)

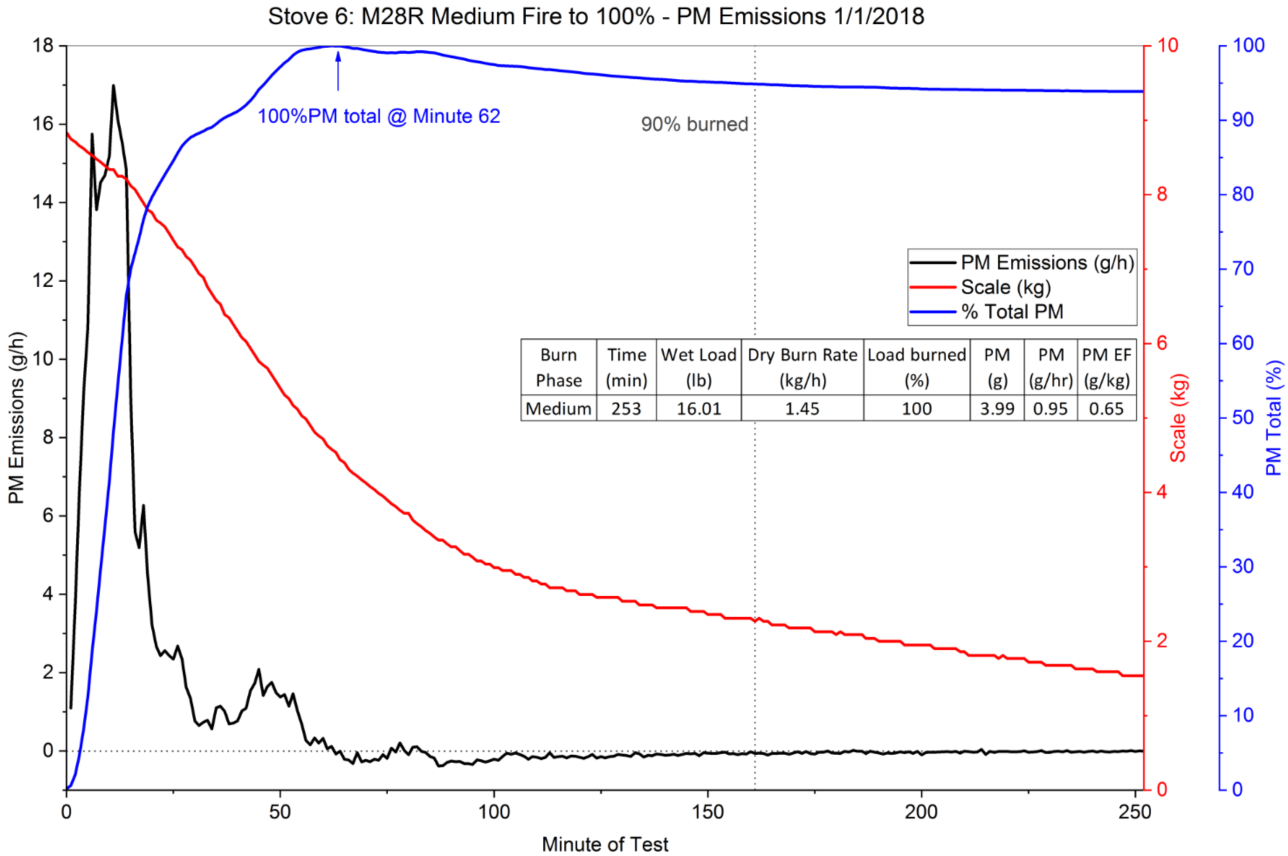
[27] Stockton, B., "Addressing the Issue of Wood Loading Factors of Woodstoves: How much wood to homeowners load in their stoves?" January 14, 29185. EPA documentnA-84-49-II-I-64, p.3.
[28] Intertek, "Inspection Tests and Evaluation of SBI - Series 1.7 (Blackcomb) Emissions and Efficiency - EPA (43615)." April 27, 2018, p. 160-163. Available at: https://sbiweb.blob.core.windows.net/media/4563/blackcombii-17-series.pdf.

3	Low	199	89%	215	224	Y (90 min)
	Medium	2	0%	403	598	Y (349 min)
	High	89	64%	93	139	Y (47 min)
4	Low	157	100%	115	157	Y (7 min)
	Medium	71	100%	48	71	Y (8 min)
	High	21	66%	25	32	Y (7 min)
5	Low	214	72%	190	298	Y (82 min)
	Medium	209	56%	243	373	Y (165 min)
	High	35	30%	89	115	Y (54 min)
6	Low	77	27%	188	281	Y (207 min)
	Medium	62	25%	164	251	Y (175 min)
	High	86	69%	78	125	Y (29 min)

As highlighted in Figure 6, using a gram per hour standard, current certification testing that averages emissions over a long testing time minimizes the importance of peak emission periods and yields results that suggest the units are lower emitting than they will be in actual use. In the example above, the unit emitted 4 grams of particulate in 62 minutes, while no additional PM was measured during the remaining three hours of the test. In fact, some PM was lost, likely due to volatilization of semi-volatiles. Because start-up emissions are much higher than those at steady-state, this approach results in unrepresentatively low emissions during the certification test.

EPA's assumption that units spend long periods of time at a single air setting is not substantiated by the in-use data obtained by data loggers deployed by NESCAUM (see materials in Attachment 23), which substantiates information from earlier EPA studies included in Attachment 24.

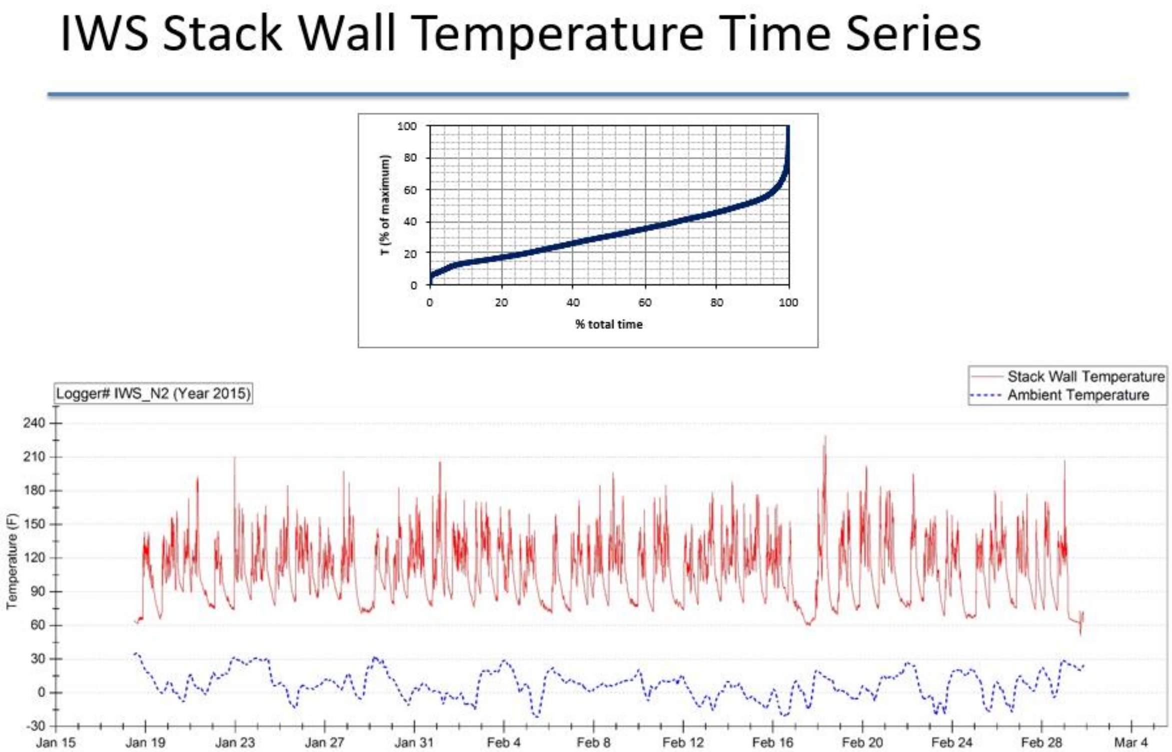
Figure 6. Real-time PM Emissions – Method 28 Category 2



* Real-time PM Measurements obtained with Teom. On average Teom measurements are 10% less than filter measurements.

Figure 7 is a sample of data logging of stack temperatures over several months at *in situ* locations across the Northeast. These data show that units do not remain at steady-state loads, but rather experience significant load changes. The data suggest that units cold start 1.14 to 1.44 times per day with multiple reload events of varying degrees, typically 3-6 times per day. Higher peaks correlate with the loading of more wood and higher air settings. The observed peaks and modes show that user patterns are highly variable. These data correlate with EPA studies from the 1980's, contained in Attachment 24. Our data logging demonstrates that the heat load categories in Method 28 WHH do not reflect typical patterns and that certification tests based on these categories lead to an underestimation of in-use emission.

Figure 7. Data from Study Tracking *In-situ* Stack Temperatures



3.1.1.4 Fuel Species/Density

Wood species, density, moisture, resin content, and bark all impact emissions from combustion.[29] NESCAUM and BNL conducted an exhaustive literature review of existing data related to the emission impacts of species (see Attachment 25). All studies found that species effected emissions, but the directional impact varied based on the parameters controlled for in the study.

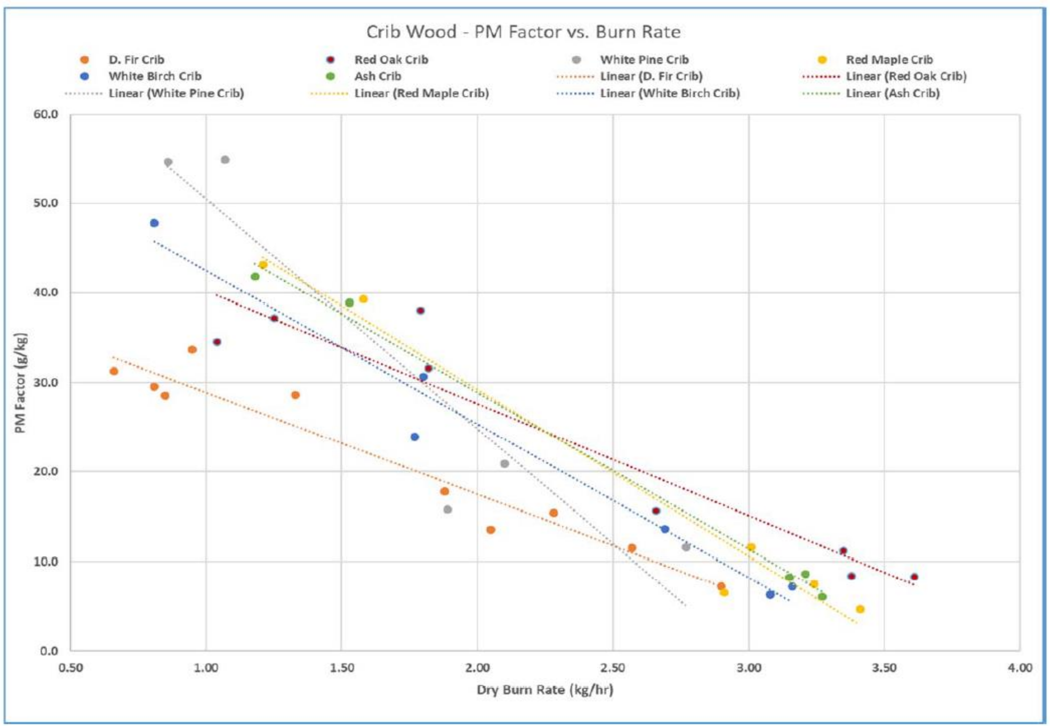
EPA undertook a study of a pre-NSPS stove to assess the uncontrolled emission impacts of varying species within the test method. One of EPA's primary conclusions was, "Study results seem to indicate that species does matter in terms of PM emissions, at least on the pre-1988 stove

[29] Butcher, T and Trojanowski, R., "Summary of Literature Review for Wood Species Impact on Emissions." September 2016, Brookhaven National Laboratory, included in Attachment 25.

used in the species study (which had minimal emission control technology)."[30,31] These results confirm findings of numerous other studies that species will introduce variability into testing results, more so than the move from crib fuel to cordwood fuel.

Current EPA crib methods only allow the use of one fuel, which is feasible for dimensional lumber and decreases method variables. For cordwood tests, limitations on the transport of untreated wood requires the use of a local species as test fuel. The ASTM cordwood test method focuses on the use of the specific gravity range of the wood, rather than species. This allows a large number of species to be used in testing, which introduces new and significant variability issues. As described above and highlighted in Figures 8 and 9, the premise that there will not be much difference in emissions across species under the very narrow specific gravity range stipulated in the ASTM method is not supported by the data in the EPA study.

Figure 8. Comparison of Six Wood Species: PM Emission Factors vs. Burn Rate [32]

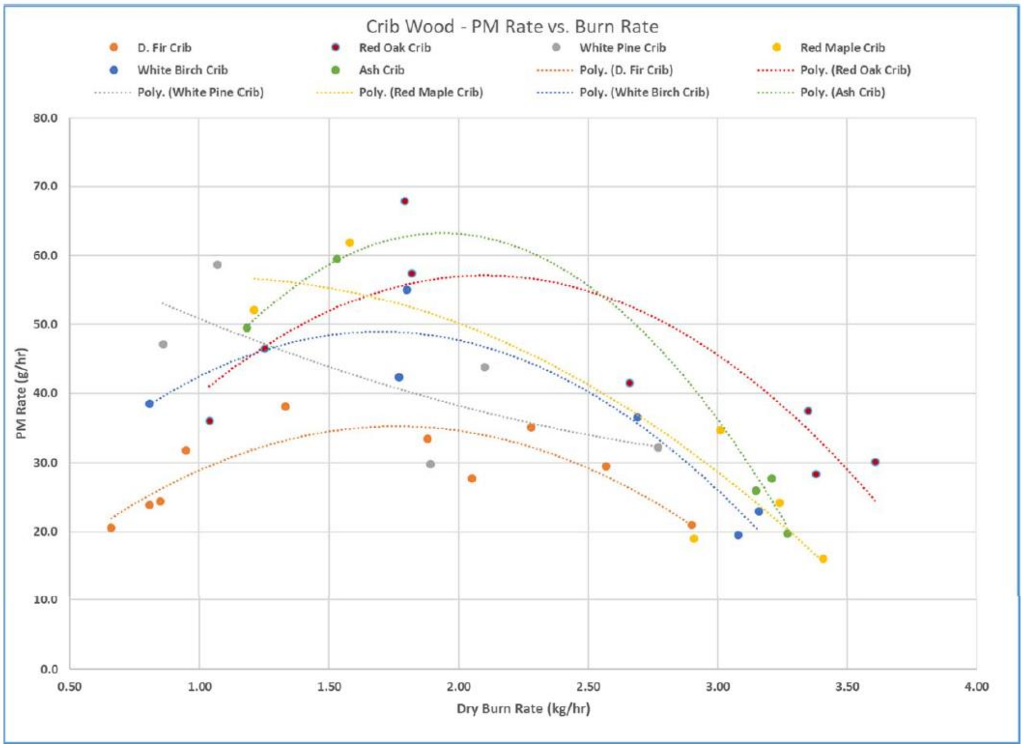


[30] Cole, D., "Final Report: Wood Species Testing Using Crib and Cordwood in a Pre-NSPS Residential Wood Heater." Page 12, US EPA, March 4, 2017. Prepared under EPA Contract No. EP-D-12-001Work Assignment #4-08.

[31] Presentation by US EPA, Notes for Operational and Fueling Protocol Workgroup Meeting, contained in Attachment 19.

[32] Cole, D., "Final Report: Wood Species Testing Using Crib and Cordwood in a Pre-NSPS Residential Wood Heater." Page 12, US EPA, March 4, 2017. Prepared under EPA Contract No. EP-D-12-001Work Assignment #4-08.

Figure 9. Comparison of Six Wood Species: PM Emission Factors vs. Burn Rate [33]



To address the concerns of limiting variability, NESCAUM recommends that EPA allow only two widely available species (e.g., maple) with specified allowable densities for testing all residential wood heater devices. We also urge EPA to require measuring and reporting of fuel density in all test reports. NESCAUM's current research agenda anticipates obtaining more data on this critical parameter as additional analysis is needed to determine how to better reflect in the certification test methods the range of actual (in-home use) moisture content, while at the same time reducing unnecessary variability.

3.1.2 Operational Protocol

In order to best replicate real-world emissions, testing must be conducted to assess numerous parameters, such as varying heat demands, different sized fuel loads, and different piece sizes. Most importantly, there must be three test runs with the results averaged, as required for other stationary source emission testing, to assure the final result reflects the appliance's emission and efficiency variability.

The current practice of burning a single fuel configuration at one heat setting for the entire fuel load, with no start-up or reloading events, does not properly reflect typical heat load patterns.

[33] Ibid.

Certification results based on these categories in the test method lead to an underestimation of emission levels compared to actual (in-home use) emissions. Current testing procedures smooth peak emissions and fail to accurately characterize how the appliances are typically operated at home. In actual practice, units are not operated in consistent batch loads under steady-state conditions as currently tested. Batch sizes (fuel loads) vary and heat settings are changed both before loading a batch and while burning it. Stoves in homes tend to be loaded more often, with smaller batches than those used in the lab, and heavily loaded for overnight burns.

Steady-state testing of central heating units is even further removed from the reality of in-use practices. In the home, these units respond to calls for heat via thermostats. Therefore, home heating demand will more closely follow variable loads over a single day, sometimes with on an on/off cycle or with a combination of turndown ration and on/off cycles, as recognized by ASHRAE 103 testing, “Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.” In recognition of this in-home use pattern, current steady-state testing must be replaced with a test method that includes replicates and a single test run that mimics the cyclic operation patterns typical of thermostatically controlled appliances.

NESCAUM urges EPA to adopt the use of operational protocols that better reflect documented user practices. To obtain results that better account for in-home use in the future, EPA must revise test methods to allow for replicate testing to assure that results reflect average performance, not steady-state results, which can be considered outliers relative to typical in-home cyclical patterns.

In the interim, EPA should assure that units are tested at low load operations. NESCAUM’s position has and continues to be that “It is vital that all residential wood heating devices be tested at their lowest burn setting and that they be manufactured to permanently prevent alteration of this low burn setting.”[34]

The 2015 Residential Wood Heater NSPS rule states that a unit cannot be sold to operate at loads lower than tested.[35] Our review, however, of many test reports and ATMs indicates that devices have not been tested at the lowest loads. Our review also shows that key appliance settings, such as boiler setpoints, are not included in the test reports or the setpoints are being changed for each load category. This practice yields results that are inconsistent with real-world operations and emissions. EPA does not devote the necessary resources to obtain units and test them to assure that appliances are complying with these requirements and are tested in a manner consistent with in-home use. NESCAUM urges EPA to direct funding to conduct testing that demonstrates

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[34] NESCAUM Comments on EPA’s 2014 proposed NSPS rule for Residential Wood Heater. May 5, 2014, p.17. Available at https://www.nescaum.org/topics/wood-biomass-combustion.

[35] §60.533(b)(5) and §60.5475(b)(5).

compliance with low load operation and are done with realistic settings, specifically for Subpart QQQQ units.

EPA should also eliminate loopholes in current test methods that allow the use of manufacturer instructions, which may or may not be included in the test report, to avoid conformance with fueling and operational procedures. The final sentence of § 60.534(h) states that, "All communications must be included in the test documentation required to be submitted pursuant to § 60.533(b)(5) and must be consistent with instructions provided in the owner's manual required under § 60.536(g), except to the extent that they address details of the certification tests that would not be relevant to owners or regulators." The final clause creates a loophole that allows manufacturers and test labs to withhold critical testing data. NESCAUM recommends that EPA immediately revise the language in this section to require that all information from the manufacturer be included in the non-CBI test report, with no exceptions allowed. Additional examples of manufacturer's instructions allowances creating loopholes can be found in Sections 8.1.1.1, 8.12.1.3, and 16.1.2 of Method 28R and Section 8.0 of Method 28WHH. Similar issues are found in ASTM and CSA test methods and discussed in detail in Section 3.2.8.

In addition to improving operational protocols, EPA must take steps to develop more realistic efficiency metrics. Current calculations ignore significant impacts resulting from jacket losses. Additionally, EPA must create an approach that accounts for additional transmission and jacket losses that results from the outdoor installation of appliances. Currently, the efficiency calculations for indoor and outdoor units are treated in a similar manner. Based on ongoing testing and field research, NESCAUM and BNL will be making recommendations about modifications to efficiency calculations later this year. We urge EPA to work with other entities conducting research to incorporate these recommendations.

3.1.3 Replicate Testing

Current EPA and ASTM test methods conduct hot-to-hot steady-state tests in three to four predefined test categories. The lack of replicate test runs makes it impossible to determine or assess method precision or reproducibility. Typical stack testing requires that three tests be performed (an "n" of 3), while current testing for wood devices requires only one data point in four different load categories with no repeats.

Studies have shown that biomass testing may, in fact, require more than three replicates.[36] Assessment of wood-fired cookstoves requires a minimum of three and up to ten replicates to provide statistical confidence that the results are valid. Appendix 5 in Attachment 26 provides information on wood cook stove testing, with specific data on necessary replicates to obtain

[36] Wang, Y., et al. "How many replicate tests are needed to test cookstove performance and emissions? — Three is not always adequate." Energy for Sustainable Development, Elsevier, Volume 20, June 2014, Pages 21-29.

confidence in the data. A follow-up study completed by Lawrence Berkeley National Laboratory found that, "In the stove design and laboratory testing phase, researchers need to conduct a relatively large number of replicate tests to ensure with some confidence that the improvements of stove performance and emission levels are truly achieved."[37] (Study included in Attachment 27) A method with no replicates makes it impossible to assess unit variability.

Variability analysis is a critical component of the test method and the goals of the assessment must be clearly defined. In assessing method efficacy, EPA must first evaluate the three components of the test method (PM measurement, fueling protocol, and operational protocol) separately. For example, identify how to improve PM measurements precision separately from fueling variability or technology variability (e.g., the protocol needs to assess PM and fuel variability). Once that work is complete, EPA must also assess the interplay of the various components. For example, how would large volume fuel loads impact dilution tunnel dewpoints or how well does the method assess emissions from devices with very low loading? In assessing variability of the operation and fueling protocol, EPA must take steps to assure that its analysis reflects the impact of the method rather than the considerable variability in performance that is expected from poorly designed devices.

3.1.5 Particulate Matter Sampling

PM sampling and measurement can introduce significant variability. PM is not an absolute quantity, but rather an operationally-defined amount. Different sampling methods produce different PM emission results, even when other conditions are held constant. In 2016, NESCAUM facilitated a group of experts in the field of PM measurement to review and identify areas of improvement in Method 5G and ASTM 2515. A list of the group's members and their directive is included in Attachment 28. The group's conclusions that were presented to EPA and EPA-certified labs are included in Attachment 29. To date, no action from either ASTM or EPA has been taken to address the identified issues.

Current test methods such as ASTM 2515 and EPA Method 5G do not properly control for excessive dilution tunnel temperature or dewpoint, or relative humidity at the sample filter. Lower tunnel flow rates introduce water issues that have significant impact on method precision. Lower tunnel flows can also cause extremely high tunnel temperatures, up to 80 C on high fire burns. At these temperatures, little to no condensation of semi-volatile organic compounds (SVOCs) will occur, resulting in under-measurement of PM.

Consistent with the group's recommendations, tunnel flows for both methods should be increased to keep tunnel temperatures below 100°F and tunnel dewpoint at least 2°C lower than

[37] Ibid.

the filter temperature. Meeting these limits will require higher tunnel flows than are normally used. EPA Method 5G specifies a tunnel flow of 140 CFM unless the burn rate is greater than 3 kg/h, and ASTM allows flows between 150 and 500 CFM. Depending on the device being tested, flows greater than 500 CFM may be necessary to meet these temperature and moisture requirements. It is possible to estimate the needed tunnel flow based on the dewpoint of the lab makeup air, the maximum burn rate expected, and the temperature of the filter. Appropriate assumptions for water of combustion, stack flow, and the timing of evolution of wood moisture in the early phase of the burn can be made. Tunnel temperature and relative humidity (and thus calculated dewpoint) should be continuously measured in the tunnel and reported with other test data.

The combination of higher tunnel flows and lower PM emissions from clean devices such as pellet stoves requires additional precision in the filter weighing process. A semi-micro balance with resolution of at least 0.01 mg is necessary, and for some test protocols and devices, a micro balance (1 μg resolution) may be needed. In addition to a better balance, improved filter handling and weighing procedures would be needed, as recommended in the group findings.

Of immediate concern is the continued use of glass fiber filters by some testing laboratories for wood heater certification testing. As wood burning appliances become cleaner with the 2015 NSPS performance requirements, the mass loading on PM sample filters can be much lower – sometimes under 1 mg. At these low mass loadings, the issue of filter mass loss from glass filter fibers (even with recovery from O-rings) can become a large factor in determining the accuracy of net mass weight.

While glass fiber filters without binder are not as friable as quartz filters, they are not as mechanically robust as Emfab Teflon coated glass fiber filters. Recent research by NESCAUM with glass fiber filters shows an average mass loss on the back-filter for an in-use sample train of 0.3 mg (range 0.08 to 0.6 mg). This demonstrates that EPA should immediately eliminate the use of glass fiber filters for certification testing and require the use of Emfab filters, which are currently referenced as an acceptable alternative. EPA must address issues with current PM filter measurements that result in significant PM loss and affect emission variability.

EPA should build upon NESCAUM research by conducting analysis to answer two additional questions:

(1) Are SVOCs being lost from the filter during periods of clean operation?

(2) During filter equilibration, is it SVOCs or water that is being lost?

There can also be substantial loss of SVOCs during the multi-day post-sampling equilibration time currently used by the test method. Continuous PM test measurements can show the loss of volatile mass that occurs during sampling.

3.2 ASTM and CSA Cordwood Test Methods

NESCAUM does not believe that the ASTM and CSA cordwood test method, as currently designed, effectively replicates real-world conditions. Consequently, we do not endorse the ASTM or CSA test methods as the next generation of test protocols. There are several aspects of the design and implementation of this test procedure that raise concerns, including the fueling protocol, operational issues, and PM measurement.

3.2.1 Use of Cordwood is Incompatible with Dilution ASTM 2515

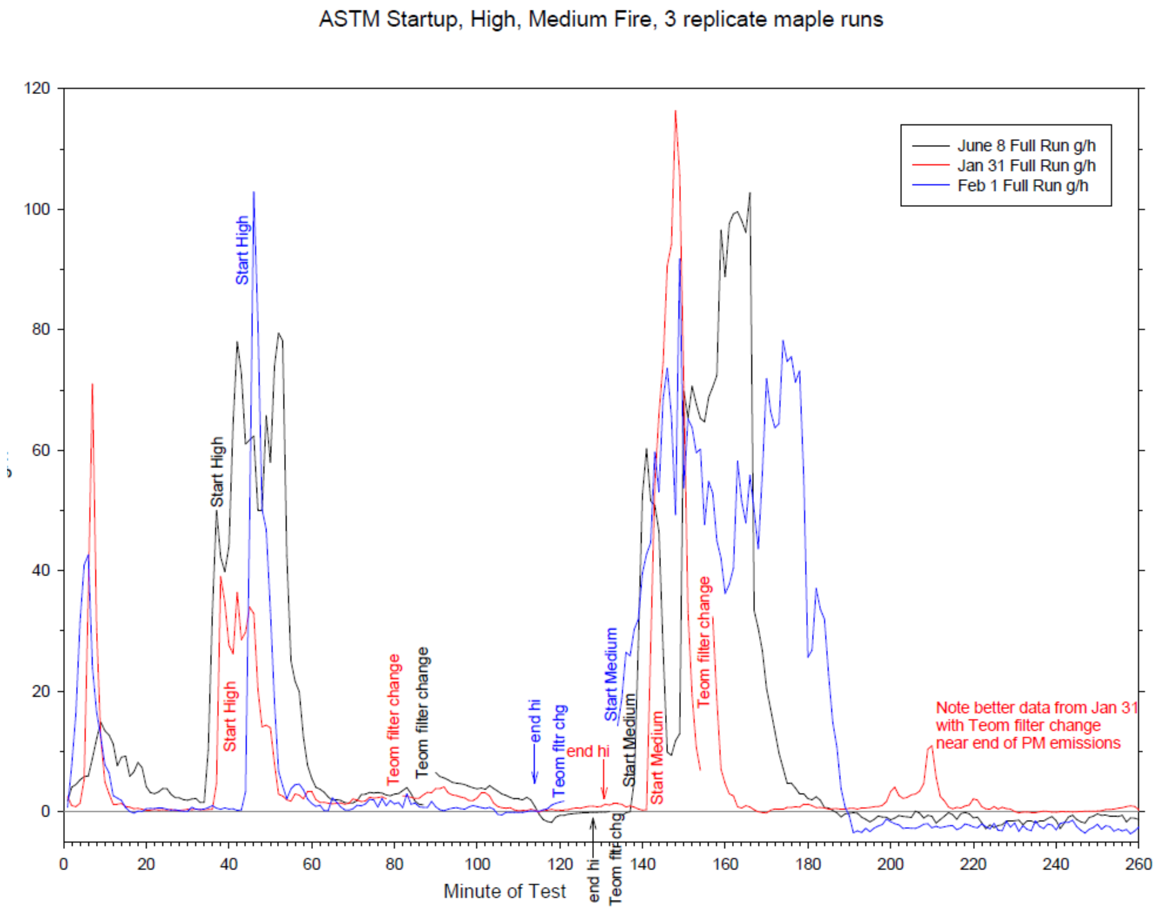
For ASTM 3053-17, ASTM 2618-13, and CSA B415.1-10 methods, it is inappropriate to use ASTM 2515 for PM measurements without revisions that address artifact concerns. ASTM 2515 was built on the assumption that Douglas Fir was the test fuel. EPA Method 5 (the overarching method for 5G and 5H, which is the basis for ASTM 2515) states that glass fiber filters cannot be used when acid gases are present. We note that sulfur is typically present in wood grown east of the Mississippi River, creating sulfur dioxide (an acid gas) when the wood is burned. Negligible sulfur levels may be a reasonable assumption for western U.S. wood species (e.g., Douglas Fir or other wood used in western test labs). However, published studies have shown that many samples of wood pellets and chips from eastern U.S. wood show concentrations of sulfur ranging from 8 to 175 mg/kg wood (ppm w/w), with a mean and median of ~75 ppm.[38]

EPA material referenced in Attachment 30 provides a compelling case to require inert filter media for wood appliance testing, which is not required in ASTM 2515. As the Q&A Section in Method 5 highlights, this artifact becomes more important when testing devices with lower PM emissions, which is the case with Step 2 devices and some of the segmented runs detailed in this method. Additional issues within ASTM 2515 need to be addressed related to the fueling and operational protocol with the shift to cordwood test fuel and new burn conditions to assure that the PM measurement method is appropriate for use with these changes. For example, high moisture conditions at start-up are likely to be encountered that will require relative humidity limits and protocols to eliminate moisture issues with filters. Additionally, research has also found that the loading protocols in ASTM 2618-13 and 3053-17 create periods early in the burn cycle with high dew points and tunnel humidity and long periods after the first portion of the burn where no PM is emitted but hot air is blown onto the filters. Both conditions lead to PM

[38] Chandrasekaran, S., et al. "Chemical Composition of Wood Chips and Wood Pellets." Energy & Fuels 2012 26 (8), 4932-4937.

losses that are captured by real-time PM measurements but not filter measurements, as highlighted in Figure 10. NESCAUM research indicates that the losses could range from 5 to 25 percent.

Figure 10. Comparison of ASTM Medium Burn Runs with Same Fuel on Same Stove



3.2.2 Definition for the End of Test

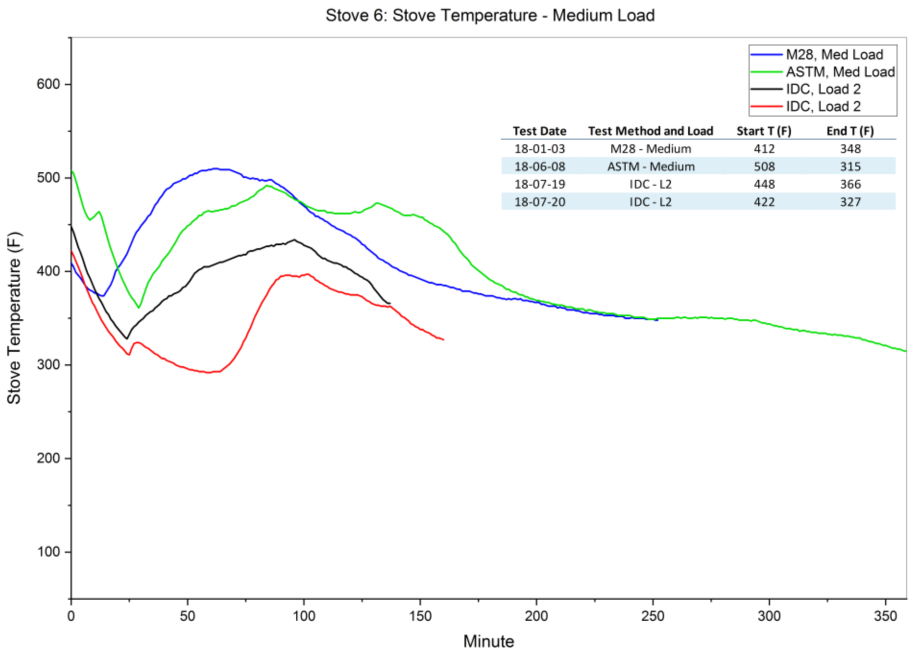
Within ASTM 3053-17, each burn category has a different definition for the end of the test run. The high fire category ends at 90 percent, while the medium and low fire burns can choose to end the test at 100 percent consumption of the fuel charge or when at least 90 percent of the test fuel load weight has been consumed and there is no measurable weight loss (< 0.1 lb (0.05 kg) or 1.0 percent of the test fuel load weight, whichever is greater) for at least 30 minutes. This is problematic for two reasons. First, providing alternative definitions within a single test run provides opportunities for gaming the system and creates needless variability among test results. This option should be eliminated to ensure consistent testing. Second, differing definitions for various runs in a test method where emissions are being averaged does not create a consistent or representative approach for the emissions the test method is capturing. The definition of what constitutes the end of the test must be consistent within and among test runs.

3.2.3 High Fire Burns Immediately Prior to Medium and Low Burn Rates

Under ASTM 2618-13 and ASTM 3053-17, testing allows completing a high burn immediately prior to medium and low burns. This allowance sets the unit at an artificially high temperature starting point. Basic engineering principles and data have shown that higher temperatures lead to lower emissions and higher efficiency results. This issue is problematic for several reasons: (1) it provides significant benefit to non-catalytic devices, with higher refractory temperatures and other combustion conditions; (2) secondary combustion will be primed for optimum performance; and (3) it creates an opportunity to game the test.

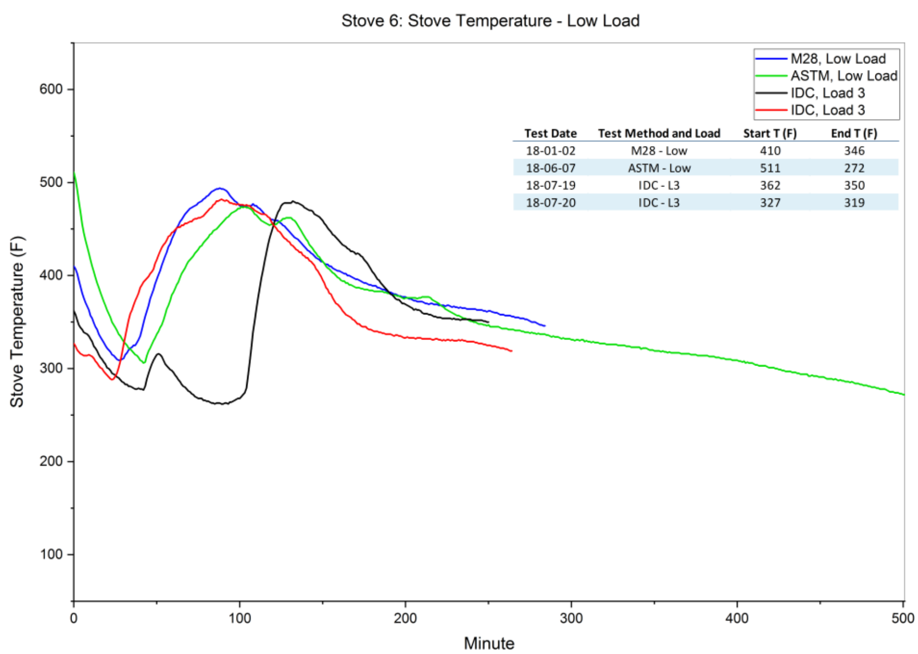
During state, industry, and EPA discussions, industry raised concerns about allowing stoves to “come in hot” to medium and low load testing. Industry raised concern with data (Attachment 31) that showed stoves coming into medium and low phases with temperatures 50-75 degrees higher than EPA M28 tests. Based on those discussions, modifications to the IDC method were made to lower the starting temperature of the stove before moving into lower load testing. These issues, however, can also be found in the ASTM test method. NESCAUM conducted ASTM 3053-17 tests on two stoves and found that the average temperature of the stove entering the low and medium categories in the ASTM is approximately 100 degrees (20%) hotter than M28R testing, as shown in Figures 11 and 12. Higher starting temperatures lead to better light off and lower emissions than would typically be seen in real-world settings. Figure 11 shows the average stove temperatures for a Method 28R Category 3 test, an ASTM Medium Burn Test, and two IDC runs during the maintenance load. The ASTM test has the stove starting at an average temperature of 60 to 100°F higher than the M28R or IDC test runs. Figure 12 shows the average stove temperatures for a Method 28R Category 1 test, an ASTM Low Burn Test, and two IDC runs during the maintenance load. The ASTM test has the stove starting at a temperature 101°F higher than the M28R. NESCAUM will be conducting similar studies on boilers and furnaces in the near future.

Figure 11. Average Stove Temperature -Med Burn Rate - ASTM, M28R and IDC protocols



Test Date	Test Method and Load	Start T (F)	End T (F)
18-01-03	M28 - Medium	412	348
18-06-08	ASTM - Medium	508	315
18-07-19	IDC - L2	448	366
18-07-20	IDC - L2	422	327

Figure 12. Average Stove Temperature - Low Burn Rate ASTM, M28R and IDC Protocols



Test Date	Test Method and Load	Start T (F)	End T (F)
18-01-02	M28 - Low	410	346
18-06-07	ASTM - Low	511	272
18-07-19	IDC - L3	362	350
18-07-20	IDC - L3	327	319

3.2.4 Moisture Content

Under ASTM 2618-13, ASTM 3053-17, and CSA B415.1-10, the measurement method used to characterize fuel moisture lacks precision and reproducibility and introduces additional variability. A NYSERDA/State University of New York College of Environmental Studies and Forestry (SUNY ESF) study (Attachment 32) concluded that accuracy to better than 2 percent moisture content is achievable by averaging four meter values; shell and core from the end and middle of each piece, with the ten pieces of split cordwood that would typically make up an approximately 50 pound fuel load.[39] The study found that the ASTM methodology might reasonably be expected to predict wood moisture content in split cordwood pieces that had very uniformly distributed and even moisture with a very minimal moisture gradient. Unfortunately, because the ASTM drying method allows the use of a broad variety of species, this approach will result in higher variability with wood that does not dry evenly.

3.2.5 Fuel Density Range

Under ASTM 2618-13, ASTM 3053-17, and CSA B415.1-10, a broad range of fuel species can be used based upon the fuel density specified. In the 2004 study, "Chemical Characterization of Fine Particle Emissions from the Wood Stove Combustion of Prevalent United States Tree Species," researchers found that emissions from the species allowed within the draft ASTM method are highly variable.[40] A 2013 study found that three parameters strongly affected emission outcomes – "the kind of wood, its physical properties, and the availability of oxygen."[41] There is a growing body of evidence in addition to the EPA 'Vigilant' study conducted in 2016 and 2017 that highlights the strong correlation between emission outcome variations and differences in the chemical makeup of various tree species.[42, 43] The range listed in the ASTM draft method is too broad to provide consistent and reproducible results and introduces unnecessary variability.

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[39] Smith, W. (et al). "Evaluation of Wood Fuel Moisture Measurement Accuracy for Cordwood-Fired Advanced Hydronic Heaters." March 2014, NYSERDA.

[40] Fine, P., Cass, G., and Simoneit, B. (2004). Chemical Characterization of Fine Particle Emissions from the Wood Stove Combustion of Prevalent United States Tree Species. Environmental Engineering Science – Environmental Engineering Science. 21. 705-721. 10.1089/ees.2004.21.705.

[41] Orasche, J., et al. "Comparison of Emissions from Wood Combustion. Part 2: Impact of Combustion Conditions on Emission Factors and Characteristics of Particle-Bound Organic Species and Polycyclic Aromatic Hydrocarbon (PAH)-Related Toxicological Potential." Energy & Fuels, 27 (3), 1482-1491, 2013. DOI: 10.1021/ef301506h.

[42] Cole, D., "Final Report: Wood Species Testing Using Crib and Cordwood in a Pre-NSPS Residential Wood Heater," page 12, US EPA, March 4, 2017. Prepared under EPA Contract No. EP-D-12-001Work Assignment #4-08.

[43] Rector, L. "Results from Washington State NYSERDA Stove Project Test Results." July 2016. Presentation included in Attachment 31.

NESCAUM research has also found that the broad variability of species and density affects emission outcomes. Longer burn times allow for estimates of erroneous lower emission rates as an artifact of the averaging calculations in the emission standard. EPA provided an additional margin of error for the cordwood standards but failed to account for the longer averaging times created by the allowance of a broad variety of species.

Tables 6 and 7 compare the testing times with ASTM 3053-17 at the medium burn category using two different species with the time it took to complete M28R Category 2 and 3 testing. Testing under M28R for Category 2 and 3 ranged from 252 to 305 minutes. ASTM Medium Category testing with maple took as long as 469 minutes, red oak took 444 minutes, while ASTM Medium Category testing with beech took 775 minutes to complete.

The time to burn all the fuel is a critical component when the emission standard is based on unit of pollution per time. Using beech with the ASTM method allowed this unit to spend 550 minutes in the charcoal tail phase, thereby allowing emissions to be averaged over an additional six-hour period. Furthermore, for the denser fuels the appliance spent a significant portion of the testing time measuring no emissions – 309 to 550 minutes. This long period without the emissions is often referred to as the charcoal tail. The longer the charcoal tail period is, the longer the time period the same amount of emissions can be averaged over, producing artificially low emission rates. Furthermore, this testing suggests that a homeowner using beech would only load the stove once every 13 hours, which is not reflective of the in-use data previously referenced. Additional comparative analysis from these test runs can be found in Attachment 33, which highlight the impact of an extended charcoal tail on the grams per hour metric and the need to retain the one-hour filter pull.

Table 6. Comparison of Time and PM Capture with Stove Tested With ASTM and Method 28R – Medium Burn Rate.

Test	Species	Total testing time min	Time to total PM min	Testing time no pm min	Ratio
M28R Med	Douglas Fir Crib	252	83	169	2.04
ASTM Med	Maple cordwood	358	49	309	6.31
ASTM Med	Maple cordwood	469	126	343	2.72
ASTM Med	Maple cordwood	454	56	398	7.11
ASTM Med	Beech cordwood	775	225	550	2.44
ASTM Med	Red Oak	444	73	371	5.08

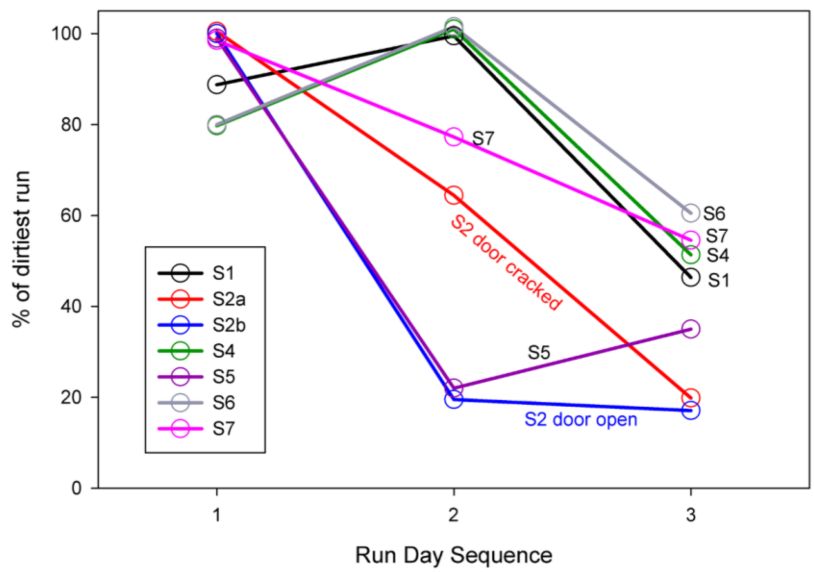
Table 7. Comparison of Time and PM Capture with Stove Tested With ASTM and Method 28R – Low Burn Rate.

Test	Species	Total testing time min	Time to total PM min	Testing time no PM min	Ratio
M28 Low	Douglas Fir Crib	282	77	205	2.66
ASTM Low	Maple cordwood	500	68	432	6.35
ASTM Low	Beech cordwood	727	211	516	2.45
ASTM Low	Red Oak	501	68	433	6.37

3.2.6 Stove Temperature

Neither ASTM nor CSA Methods specify how much burning can be done in a stove before testing begins. Only in ASTM 3053-17 does the method specify any pre-test conditions, which is that the average device and stack temperature can be up to 10°F above ambient. These temperature requirements are not sufficient to determine if the internal refractory has reached elevated temperatures. Elevated internal stove temperatures are especially beneficial to non-catalytic stoves because they decrease the time to light off secondary combustion and markedly improve emissions performance. Data obtained from NESCAUM research, shown in Figure 13,

Figure 13. Emission Outcomes Replicate Testing



indicate that testing under the same conditions on consecutive days improves appliance performance.[44] The current ASTM method does not require a set period of time when the stove cannot be used prior to starting the emission test intended to reflect cold start emissions.

3.2.7 Emission Averaging - Weighting Scheme

Averaging of the various burn categories is a critical element in determining the outcome of the test. Weighting schemes in M28 and M28HH are based on an analysis of degree-days and provide a rationale for these approaches. ASTM 3053-17 provides no technical basis for the 40-40-20 weighting scheme that is used. Further, the calculation creates a weighting that is preferential to non-catalytic devices because its weights burn categories that exhibit better

[44] Data from replicate testing for IDC protocols using the same stove, species and protocol.

emission performance for these devices more heavily than other calculations used in regulatory programs.

3.2.8 Manufacturer Instructions

ASTM Section 3.2.10 defines manufacturer written instructions as follows:

> [S]pecific information regarding the fueling and operation procedures recommended by the heater and manufacturer and included with the heater at the time of testing. Discussion - These instructions may include specific kindling and fueling instructions and recommendations such as kindling dimensions and placement (including newspaper) and ignition, dimensions of start-up fuel pieces, addition and placement of the start-up fuel, addition and placement of the main fuel load, position of the load door(s) and setting heater controls (including bypass dampers, if applicable) during start-up and subsequent operation. Instructions for refueling a hot heater when residual fuel and charcoal are present in the firebox may also be included. These instructions must be consistent with information provided to the heater end-user in the owner’s manual but may also include information that will be useful only during testing and not to the end-user.

NESCAUM is concerned that this language allows manufacturer instructions to change almost any aspect of the test, without the requirement to include these changes in the test report or the owner’s manual. Examples of issues stemming from this definition can be found in almost all ASTM tests, including ASTM 2779, ASTM 2780, and ASTM 2618-13.

3.3 Integrated Duty-Cycle (IDC) Test (ANPRM Comment Area A)

In an effort to create an improved test method for residential wood devices, BNL and NESCAUM, under a contract with NYSERDA, have developed the Integrated Duty-Cycle (IDC) test. The IDC test is designed to be accurate, representative, repeatable and affordable, and to address many of the problems identified with EPA, ASTM and CSA test methods. It incorporates emission measurements during typical operating situations, including start-up, reload, and transition from various heat output loads. The single-day test allows for replicate testing without increasing certification test costs. The protocol is complete, and the test is being used in the laboratory to assess emissions from a range of residential wood burning devices.

States invited industry and EPA to participate in the test procedure development process and they did so for some time until HPBA and industry representatives notified NESCAUM staff in the spring of 2018 that they were withdrawing from the stakeholder effort. EPA’s notes from these stakeholder meetings are included in Attachment 18 and presentation materials are included in Attachment 31. EPA’s Discussion Paper on Cordwood Test Methods made the following statement regarding the IDC methods, “The EPA believes that this is a reasonable approach to further the science and to develop cordwood methods that reflect in-home use, improve the precision of wood stove testing, and be protective of human health and the environment as the cornerstone of the NSPS certification program."[45]

Unlike ASTM methods, the IDC is undergoing rigorous analysis using a variety of appliances to assess protocol performance prior to finalizing methods. Key to achieving this goal is undertaking a method validation process, which is currently underway. To appropriately assess and use new protocols, method reproducibility, variability, validation, and appliance performance must be evaluated prior to full-scale implementation. A focus of this research is gathering data to characterize the precision of the IDC test methods. NESCAUM is in the process of completing research on 12 stoves (pellet and cordwood), 9 boilers (pellet and cordwood), and 3 furnaces (cordwood and pellet) that includes baseline testing with Method 28 or other appropriate certification methods, development of full protocols for testing, and data collection with numerous replicates and variation in fuel types to assess appliances. Drafts of current test methods are available at: https://www.nescaum.org/topics/test-methods/test-methods. Information from this testing program will be shared with interested regulatory agencies in spring/summer 2019, and if deemed appropriate, can be used to inform EPA decision-making. NESCAUM's current research agenda includes method development and variability analysis on several boilers, stoves, and furnaces. Table 8 provides a comparison of key characteristics of the IDC approach versus EPA and ASTM testing.

Table 8. Comparison of Key Characteristics of EPA, ASTM and IDC Test Method Approaches

Element	M28R	ASTM 3053-17	IDC
Operational Parameters			
Number of loading events	1	1	4
Start-up	No	Yes, combined with high fire	Yes, separate phase
High fire	Yes	Yes, combined with start up	Yes
Maintenance – semi-active attended burn	No	No	Yes
Overnight burn	Yes	Yes	Yes

45 US EPA Office Air Quality Planning and Standards, "Process for Developing Improved Cordwood Test Methods for Wood Heaters." Page 28, March 2016.

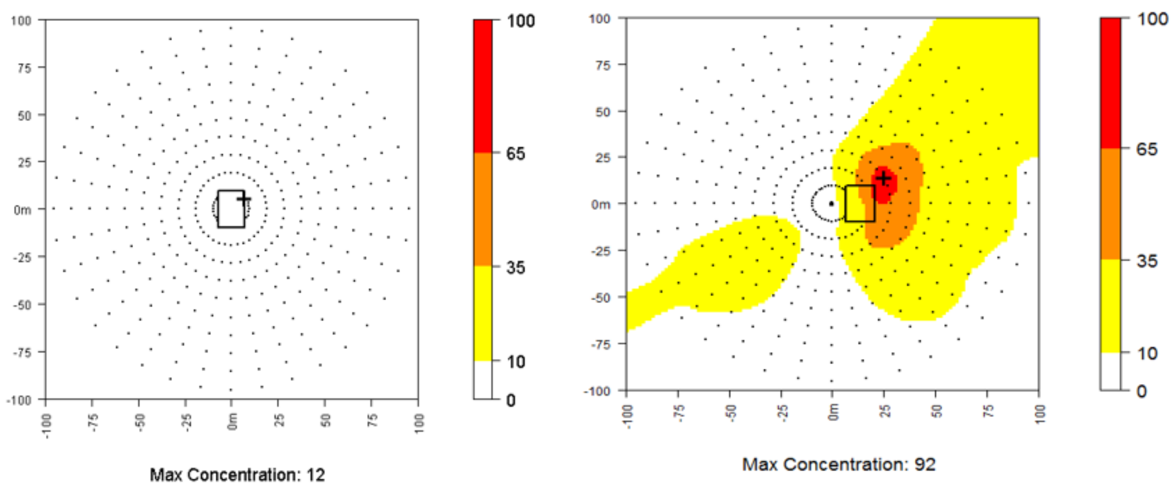
Replicates	None	None	3
Long charcoal tails	Yes	Yes	No
Protocol supported by user data	No	No	Yes
Precision and variability data	No	No	Yes
Fueling Parameters			
# of different load sizes by weight	1	2	4
# different piece configurations	1	1	4
# of allowed fuel species allowed	1	Unlimited based on density	2
Impact of species data	No	No	Yes
PM Measurement			
Real-time PM Measures	No	No	Yes
Changes in filter measurements to Increase method precision	No	No	Yes

3.4 Step 2 Emission Limit Based on Weighted Averages Versus Individual Burn Rates for Hydronic Heaters and Forced-air Furnaces (ANPRM Comment Area E)

NESCAUM opposes the use of a weighted average, rather than individual burn rates, for regulatory emission testing of hydronic heaters. Using a weighted average would constitute a weakening of the standard as it minimizes peak emissions, which significantly contribute to overall emissions that occur in actual use. This approach would move us further away from the goal of better replicating real-world emissions through the certification process. Should EPA decide to initiate such a change, the Agency would need to complete a revised BSER to support the new standard and provide a technical basis for weakening the current standard.

If EPA were to move to a weighted average, it must reinstate a requirement that no test run exceed a 5.6 g/hr cap – a 66 percent reduction in the Step 1 gram per hour cap – to reflect the relative reduction in lb/MMBtu heat output anticipated in the current standard. Weakening of the lb/MMBtu standard makes it incumbent on EPA to reinstate this cap to ensure local public health protections. Industry has submitted modeling to indicate that there are no impacts of concern for Step 1 boilers[46], however, modeling of actual EPA test data from a Step 1 boiler where emissions are apportioned by duty cycle load highlight the lack of protections provided by Step 1 emission limits. The image on the left shows modeling results when using a single averaged number. Modeled emissions based on actual hourly data show significant areas where expected ambient PM levels will be above the 35 μg/m^3 ambient standard, with the maximum area of impact experiencing emissions at 92/μg/m^3, as highlighted in the Figure 14. The New York Wood Heat report, included in Attachment 34, provides a thorough analysis of wood heating from an air quality, technology assessment and economic analysis of various wood heating applications. In assessing any new efforts, EPA should review and adopt key findings from that work.

Figure 14. AERMOD Results Using Average Versus Actual Duty-cycle Emissions



3.5 Form of the standard (ANPRM Comment Area F)

Within the 2015 NSPS, EPA created two categories with different test methods and metrics for emission standards. The "emission bins" EPA uses inform the BSER standard. If properly designed, this approach would: (1) promote and incentivize the development and sale of advanced technologies in the near-term, and (2) accommodate a smooth transition to cleaner

[46] Hearth, Patio and Barbecue Association, "HPBA's Comments on EPA's Proposed New Source Performance Standards (NSPS) for Residential Wood Heaters. Attachment 13 Tech Environmental Air Dispersion Modeling Report of the E-Classic 2300 Outdoor Wood Hydronic Heater" May 2, 2014. Available at: https://www.hpba.org/Portals/26/Documents/Government%20Affairs/NSPS%20Members/HPBA%202014%20NSPS/Attachment13TechEnvironmentalAirDispersionModelingReportofEClassic2300July2012.PDF?ver=2016-11-21-105529-197.

burning units across the categories by allowing manufacturers to continue to sell most current technology devices for a period of time while they design for the future. For the next NSPS revision, NESCAUM recommends that EPA work towards a simpler categorization that stratifies units based on heat output rather than appliance definitions, as outlined in Table 9. Appliance definitions lend themselves to units defining themselves out of the rule.

Table 9. Alternative Approach for Categorization

Delivered Heat (Btu output)	**Automatic feed – chip, pellet, etc.**	**Hand fed**
<10,000	*x* lb/MMBtu heat output No run to exceed *y* g/hr	*x* lb/MMBtu heat output No run to exceed *y* g/hr
10,000-60,000	*x* lb/MMBtu heat output No run to exceed *y* g/hr	*x* lb/MMBtu heat output No run to exceed *y* g/hr
60,001- 120,000	*x* lb/MMBtu heat output No run to exceed *y* g/hr	*x* lb/MMBtu heat output No run to exceed *y* g/hr
120,001 – 250,000	*x* lb/MMBtu heat output No run to exceed *y* g/hr	*x* lb/MMBtu heat output No run to exceed *y* g/hr
>250,000	*x* lb/MMBtu heat output No run to exceed *y* g/hr	*x* lb/MMBtu heat output No run to exceed *y* g/hr

Conclusion

Timely emission reductions from the sources covered by the 2015 NSPS are achievable for residential wood heating devices that will better protect public health and the environment. Many regulated companies have made significant progress to demonstrate the feasibility of achieving the 2020 standards according to the schedule laid out in the 2015 NSPS. Considering changes to the rule four years after its final promulgation despite this demonstrated progress, and proposing additional rulemakings into 2020 that threaten to further prolong the public’s exposure to harmful PM2.5 pollution, are unnecessary and largely designed to provide relief for those regulated entities that failed to make timely investments in rule compliance.

With the 2015 rule, EPA struck a balance by adopting viable BSER emission limits, which directed the market to move to advanced technology wood burning devices in the near-term while also creating pathways to accommodate industry concerns. The 2015 rule built a smooth transition to cleaner burning units across categories by allowing manufacturers to continue to sell most current technology devices for a period of time while they design for the future. The industry, however, must now move on to cleaner, more efficient appliances as laid out in the 2015 NSPS without further delay.

The legitimate issues raised by EPA regarding test methods are appropriate for action, but that action should occur under NSPS activities mandated for the next review due in 2023. States are well positioned to assist EPA during the next NSPS review cycle, having already invested millions of dollars into research for new methods to assess residential wood heating. EPA should work with its state partners to build on their work as it moves to address emissions from this critical source category.

The Step 2 NSPS standards taking effect in 2020 are long overdue and supported by the record established in the 2015 rulemaking. They can be met by industry today. Any weakening of these standards is neither warranted nor acceptable, and unnecessarily poses a threat to public health for years to come. It is not EPA's responsibility to protect laggard manufacturers from their own poor decisions. EPA's responsibility, as directed by Congress under the Clean Air Act, is to protect the country's air quality so as to promote public health and welfare. EPA must fully implement this highly cost-effective rule according to the schedule laid out in the 2015 NSPS.

Sincerely,

Paul J. Miller
Executive Director

cc: NESCAUM Directors
William Wehrum, EPA OAR
Peter Tsirigotis, Mike Koerber, EPA OAQPS
Cynthia Greene, Bob Judge, EPA R1
Rick Ruvo, EPA R2