Part 3 of a Review

Using “Stove 7” to Unmask The Failure of ALT-140

“Stove 7” is 1) on ADEC’s Approved List; 2) It is a High-Mass Catalytic Hybrid, and EPA Certified

With 3) Emissions of 0.7 g/hr, 4) 77% HHV Efficiency, and is 5) Eligible for the IRS 26% Tax Credit

So,

Why does EPA’s newly approved ALT-140 fail this stove? (and all other stoves?)

After millions of taxpayer dollars spent, years of testing, and results cloaked in secrecy,

ALT-140 has yet to yield a single successful test series. Why is this?

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Introduction

This Part 3 further explores the problematic nature of the Integrated Duty Cycle Test Methodology (IDCTM), which has been approved by EPA as alternative test method (ALT-140). For simplicity sake, I generally use the acronym IDC/ALT-140 to describe this method. An additional review about this method will follow this one.

ALT-140 does not require the use of a Tapered Element Oscillating Microbalance (TEOM) for measurement of Particulate Matter (PM). This is significant because much of the structure of IDC/ALT-140 was dictated by the use of a TEOM, as described below.

NESCAUM and EPA have conducted a significant number of tests using IDC/ALT-140. NESCAUM has released summary results for seven of the stoves it has tested, but the underlying data is secret. EPA has released neither summary results nor underlying data for its tests using IDC/ALT-140. As a consequence of this secrecy, Part 3 relies heavily on summary results published in the 374-page "Interim Report" as well as other publicly available information.

The Data that ADEC provided to EPA for "Stove 7"

In April 2020, Alice Edwards from the Alaska Department of Environmental Conservation (ADEC) asked EPA to approve the IDCTM as an alternative Test Method (ATM). In support of her request, she submitted a copy of NESCAUM's "Interim Report" and test data for two stoves: "Stove 17" and "Stove 7". Both stoves had emissions above 2.0 g/hr, the current EPA emissions ceiling. "Stove 17" had data that was missing and/or disordered, so Alaska withdrew the data for "Stove 17." ADEC chose instead to rely solely on data from testing of "Stove 7" to prove that the IDC/ALT-140 was a viable method.

The initial data on "Stove 7" consisted of three runs from July 2018, and one run from April 2020 (almost 2 years later). The summary results from April 2020 were submitted to correct for a "loading problem" in one of the 2018 runs. In reality, <u>two</u> of the 2018 runs had "loading problems" and failed the IDC/ALT-140 procedural requirements, because on two runs the required amount of wood for the final and biggest load simply wouldn't fit into the firebox. When I look at 24 test runs from NESCAUM's "Interim Report", all using maple cordwood as fuel, 15 of the 24 runs fail for the same reason. (See chart on page 13)

So, even if the April 2020 run was accepted as an additional run (after 2 years!) this series of tests fails to meet the IDC/ALT-140 standards for three reasons: 1. There aren't three consecutive test runs that meet the minimum requirements of IDC/ALT-140 (and no hint in IDC/ALT-140 that one could continue a failed test series after a two year interlude); 2. Two runs fail the IDC/ALT-140 density requirement; and 3. Overall emissions for "Stove 7" exceed the current EPA standard of 2.0 g/hr, no matter which runs are used to calculate emissions. These failures are important, for the reasons discussed below.

EPA Certification Test Results and NESCAUM Test Results for "Stove 7"

"Stove 7" is identified in the "Interim Report" as "Stage 2" approved; a "High mass, 1.9 ft^3 Firebox/Medium, Hybrid catalytic/non-catalytic, Step 2 cert value <2.0g/hr". I can find only one stove in the combined EPA and ADEC databases that meets these criteria. That stove is the Hearthstone Castleton 8031. Accordingly, I am proceeding on the basis that my identification is correct. The Hearthstone Castleton 8031 was tested with Method 28 in 2017 and certified by EPA with results of 0.7 g/hr emissions and 77% efficiency. This stove is listed on the ADEC "approved list." The Castleton 8031 is now probably one of the most tested stoves in the history of EPA testing. In addition to the four original EPA certification tests (performed by Polytests in 2017), "Stove 7" has been tested at least 20 times by NESCAUM from 2018-2020. NESCAUM managed to replicate the M28 Emissions results with the Castleton 8031, and NESCAUM's additional testing using ASTM E-3053 yielded emissions of 1.065 g/hr, which clearly meets the 2020 standard. However, NESCAUM has never achieved current certification values of <2.0 g/hr using IDC/ALT-140.

The Castleton 8031 has probably been tested so many times because it is a "catalytic hybrid". Catalytic hybrids are among the easiest stoves to test for emissions (and pass) because they have redundant emissions control systems, and the redundant control systems make it very forgiving in the test environment. If you look at the publicly available test report for the Castleton 8031 (available on the Hearthstone website) the catalyst is active almost instantly just after light-off and fully engaged within a couple minutes for each run (not surprising since the foil in the catalysts is just 50 microns thick). If NESCAUM/ADEC can't get a low-emitting catalytic hybrid to pass the IDC/ALT-140, then the method is in trouble.

Never has "Stove 7" Achieved <2 g/hr Emissions Results With a series of IDC/ALT-140 Tests, but EPA Approved IDC/ALT-140 Based on "Stove 7" Results

It's not surprising that NESCAUM would choose to use a stove like this to prove the merit of its test. What is surprising is that NESCAUM has been testing this stove over and over since 2018, and they have yet to produce a series of three consecutive tests with IDC/ALT-140 where this stove is below the current EPA limit of 2.0 g/hr. In addition, the efficiency numbers generated by NESCAUM for "Stove 7" are abnormally low. In fact, nearly all stoves tested by NESCAUM (as reported in the "Interim Report") have what appear to be unreasonably low efficiency numbers. Without access to the data, we cannot determine why.

The Castleton 8031 was approved by ADEC and added to its approved list, with sterling EPA certification numbers from the Method 28 testing done by Polytests in 2017. The 2017 EPA Certification results are reported on page 3 (Emissions of 0.7 g/hr, HHV average efficiency of 77%). Surely ADEC must have been aware of the irony that it's submissions to EPA in support of approval for ALT-140 contained summary results from Method 28 and ASTM E-3053 that tightly correlated with the original Castleton 8031 EPA certification values. However, NESCAUM's tests with IDC/ALT-140 both fail to achieve less than 2.0 g/hr and are the furthest from the original certification values.

Nevertheless, EPA looked at the data and somehow managed to conclude that the "Stove 7" data "provided to us by Alaska give us credible evidence that an appliance can meet the emissions limit when tested using this methodology" (Steffan Johnson in an email to me dated 1/10/22). So far, there is no real evidence that "an(y) appliance can meet the emissions limit," but perhaps EPA will change the limit (from 2.0 to 2.5 g/hr), as they did with ASTM E-3053. I have asked EPA whether the "emissions limit" with IDC/ALT-140 is the established limit of 2.0 g/hr, or whether they plan to increase the limit to 2.5 in a "special incentive" bait-and-switch trick like they did with ASTM E-3053? My question has been replied to with silence.

Will EPA do another Bait-And-Switch Trick with IDC/ALT-140?

The only way "Stove 7" passes an emissions certification test with IDC/ALT-140 is if the EPA increases the allowable emissions for IDC/ALT-140 from 2.0 to 2.5 g/hr (like it did as an inducement to use ASTM E-3053). The increase of the emissions limit to 2.5 g/hr for ASTM E-3053 was a poisonous bait-and-switch deceit that is not likely to work again, especially for a new, secret method. The last bait-and-switch for ASTM E-3053 cost me well over $100,000, mainly in testing costs to certify stoves to the 2020 standard using ASTM E-3053. Would I go for another bait-and-switch with IDC/ALT-140? Are you kidding?

This is not a frivolous question. By my count, there are 28 companies that tested approximately 90 stoves with ASTM E-3053 with both encouragement and inducement from EPA (via increased emissions limits). ASTM E-3053 was developed over 8 years, and the working group included many EPA officials and state regulators. The NEW method (IDC/ALT-140) was developed in less than half that time, by a very small group of people. IDC/ALT-140 clearly has problems, and virtually all the relevant data is still secret. Could anyone from EPA keep a straight face when asking management from any of those 28 companies to "try our new IDC/ALT-140 method?"

Anyway, The NESCAUM's modified M28 tests (0.44 g/hr) and the ASTM E-3053 tests (1.065 g/hr averaging all data) nicely bracket the original certification results of 0.7 g/hr for "Stove 7." NESCAUM's two series of IDC/ALT-140 tests, one with Maple (2.37 g/hr over three runs in 2018) and one with Oak (2.20 g/hr over three runs in 2019) were 338% and 314% greater than the original certification value of 0.7 g/hr (2.37/0.7=3.386; 2.20/0.70=3.142). I wonder if these variances bother anyone?

Abnormally Low Efficiency Calculations with IDC/ALT-140. Why?

To make matters even worse, regardless of the test method used by NESCAUM for the Castleton 8031, all of the efficiency numbers resulting from NESCAUM tests are substantially below the original EPA certification value of 77% HHV, and would disqualify this stove from eligibility for the IRS 26% Federal Tax Credit.

Average efficiency for NESCAUM's three M28 baseline tests was just 61.73%, more than 15 percentage points below the original certification value of 77% using the same test method. Similarly the weighted average efficiency for two full ASTM E-3053 tests (including

2 start-ups, 2 high burns, one medium burn, and one low burn) was 63.04%, an almost 14 percentage point drop from the original EPA certification value.

These efficiency calculations are completely inexplicable to me. IDC/ALT-140 allegedly has a new method of measuring efficiency. The formula is included in IDC/ALT-140, but I have yet to see a sample calculation applied to an actual data set, so this new method is, like almost everything else in this method, still a secret. How the values derived from the formula are averaged and how an actual "efficiency number" is calculated have not been disclosed. This is probably because either the formula has never been used, or because they produce "abnormal" results (as in "abnormally low"). Since they are still secret, we have no way of knowing.

Most of the calculations in the "Interim Report" have been done with CSA B415, an established method of calculating efficiency with visible calculations and a narrative and mathematical rationale for the calculations. The relevant spreadsheets for CSA B415 are locked, but the calculations are visible, so it's easy to follow the calculations and understand the logic behind them. One might not agree with the basis or the logic, but it has been clearly stated, used since at least 1992, and is understood and agreed to by this industry. It's an entirely different situation with IDC/ALT-140, where there are simply no sample calculations or other evidence to use to evaluate the efficiency calculation. It's still a secret.

One of the problems with test standards developed in secret, by very few people, is that there can be a long wait time (months or years) for the developer to realize an error, and potentially another long wait time (months or years) to correct it. That is the stage we have reached in January 2022; EPA has adopted the same secrecy as NESCAUM, and is now in the middle of a long unraveling, reconstruction and resuscitation of IDC/ALT-140. EPA keeps promising to make data available from its own testing of IDC/ALT-140, but the date such data might be available keeps getting pushed back. I don't think the end is in sight.

No Stove Will Test Over 75% HHV Efficiency with IDC/ALT-140
Which Means Any Stove Tested with IDC/ALT-140
Will NOT be Eligible for the IRS 26% Federal Tax Credit

The IDC/ALT-140 test results would knock the Hearthstone 8031 out of qualifying for the current 26% federal tax credit for low-emitting/high efficiency stoves that exceed 75% HHV efficiency. I have repeatedly stated that no stove will achieve 75% HHV efficiency with the IDC/ALT-140 – not because the stoves are inefficient, but because the IDC/ALT-140 method arbitrarily penalizes stoves on the efficiency calculation. The IDC/ALT-140 method consists of four loads: kindling, high fire, medium fire, and low fire. Since 10% of each load (by weight) remains in the stove, the size, volume, and amount of energy in each successive coal-bed increases. (Data from NESCAUM shows that a majority of the time, the final load required by ALT-140 will not even fit into the firebox (see chart on pg 13) because of the volume of the large coal-bed at the beginning of the final, and largest load, simply takes up too much volume to fit the load in the stove). Of equal importance, there is no evidence, so far, that the new efficiency calculation in IDC/ALT-140 will be capable of accounting for the amount of energy in these coal-beds.

In virtually all of the test summaries from NESCAUM, efficiencies are calculated using CSA B415, rather than NESCAUM's own stated method, which I call the "efficiency calculation work-around." The "efficiency calculation work-around" was undoubtedly the solution (maybe I should say *"proposed solution")* for getting around trying to account for burning *multiple partial loads* in a single test run. In response to multiple requests going back over six months, EPA has never been able to provide me with a single sample efficiency calculation, performed with the formula EPA itself approved (IDC/ALT-140).

As I stated above, I don't believe that any stove tested with IDC/ALT-140, using the formula in EPA's approved method, will achieve 75% HHV efficiency. I have invited EPA or NESCAUM to prove me wrong, but all I get is silence. I wonder why?

Problems with "Force-Feeding" the Test Stove in IDC/ALT-140

IDC/ALT-140 produces huge coal-beds. The protocol causes "force-feeding" of the test stove so that the stove is "loaded to the gills" and the final, biggest load frequently will not fit into the stove, on top of the large coal-bed. There are two problems with this protocol:

First, over-filling or "force-feeding" a stove so that the firebox is *completely* full is a strategy that is likely to reduce or disable the secondary combustion system, which is typically located in the top of the firebox, by restricting airflow in that area. This will yield lower efficiency values and increased emissions.

Second, the protocol creates an "overloaded" low burn in the final phase of a test, which is abnormal, artificial, and contrary to both normal use and design intent for most stoves. I haven't had time to compare this loading protocol to EPA's own "Burn Wise" program, but I am reasonably sure that the IDC/ALT-140 "force-feeding" protocol would be contrary to everything EPA itself advises consumers to do. The IDC/ALT-140 protocol doesn't test "real-world" conditions, but rather "stove-abuse conditions;" conditions that might otherwise be termed "Burn Stupid".

"Stove 7": What Repeated Testing Tells Us

NESCAUM tested the Hearthstone Castleton on July 25, 26, and 27, 2018 (IDC Final Protocol); on February 20, 21, and 22, 2019 (Method 28); on February 25 and 27, 2019 (ASTM 3053-17); March 25, 26, 28, 29, and 30, 2019 (IDC Final Protocol); April 3, 4, and 5 2019, (IDC Final Protocol); and April 29, 2020 (IDC Final Protocol). It was thus on a test stand for at least 17 days, with sometimes multiple tests performed on the same day (The Interim Report lists 19 tests of this stove; I count 20).

In a 12/20/21 Memorandum, Richard Wayland of EPA states that ADEC has accused test labs of "explor(ing) in its testing to find approaches for passing any appliance, regardless of design..." It seems that NESCAUM has almost the complete opposite approach, which is exploring in its testing to find approaches for failing any appliance, regardless of design.

Five sets of test results for the Castleton 8031 (including the original certification results) are reproduced below. Note that the first three boxes, which consist of two Method 28 tests and one ASTM E-3053, all have similar, low, and passing emissions figures, while the two IDC/ALT-140 tests at the bottom do not. Some of the efficiency calculations (right hand column) are just completely inexplicable to me.

STOVE 7 – 5 TEST SETS

Original Method 28 Test, July 2017 (by Polytests)						
	Test Time	Dry Burn Rate Kg/hr	Total PM (g)	PM Emissions Rate (g/hr)	PM Emissions Factor (g/kg)	HHV Efficiency
High	168	1.77	4.135	1.477	0.83	72.79%
Medium	200	1.49	1.81	0.544	0.543	76.00%
Low	307	0.96	2.79	0.546	0.5452	79.4
Low	315	0.95	2.49	0.475	0.05	78.6
	990					
Weighted Particulate Emissions (4 runs) 0.69 g/hr excellent						excellent
Weighted HHV Efficiency (4 runs) 77.0%						
4 runs, 4 days, 990 Total Minutes (16,5 hours test time)						

NESCAUM Method 28 Tests, February 2019 (by NESCAUM)						
	Test Time	Dry Burn Rate Kg/hr	Total PM (g)	PM Emissions Rate (g/hr)	PM Emissions Factor (g/kg)	HHV Efficiency
High	192	1.57	1.37	0.43	0.27	53.20% ??
Medium	222	1.38	2.11	0.57	0.42	61.50%
Low	365	0.84	2.01	0.33	0.39	70.60%
	779					
Average Emissions (3 runs) 0.443 g/hr excellent 0.44						WTF?? need to see data/calc
3 runs, 2 days, 779 minutes (12.98 hours test time)						

NESCAUM TEST USING ASTM 3053-17 2019 (by NESCAUM)						
	Test Time	Dry Burn Rate Kg/hr	Total PM (g)	PM Emissions Rate (g/hr)	PM Emissions Factor (g/kg)	HHV Efficiency
Start	61	2.38	6.16	6.06	2.54	62.90%
High	162	2.43	3.49	1.29	0.53	62.5
Low	454	1.05	3.95	0.52	0.5	69.2
Start	61	2.63	2.9	2.85	1.08	63.50%
High	152	2.46	13.48	5.32	2.16	61.4
Medium	331	1.27	1.87	0.34	0.27	57.1 ?
	1221					
Weighted Average E 1.065 gm/hr excellent						WTF need data/calc
2 runs, 2 days 1221 Total Minutes (20 hours test time)						

NESCAUM TEST USING IDC/ALT-140 (Maple): 2018 (by NESCAUM)						
	Test Time	Dry Burn Rate Kg/hr	Total PM (g)	PM Emissions Rate (g/hr)	PM Emissions Factor (g/kg)	HHV Efficiency
	672	1.52	22.43	2.8	1.32	70.2
INVALID	647	1.49	17.95	2.3	1.12	70.2
INVALID	661	1.47	13.56	2	0.84	70.3
	1980			2.37		
Average Emissions (3 runs) 2.37 FAILS 2.0 LIMIT						
3 runs, 3 days, 1980 Total Minutes (33 hours)						

NO INS 26% TAX CREDIT WITH THIS METHOD!

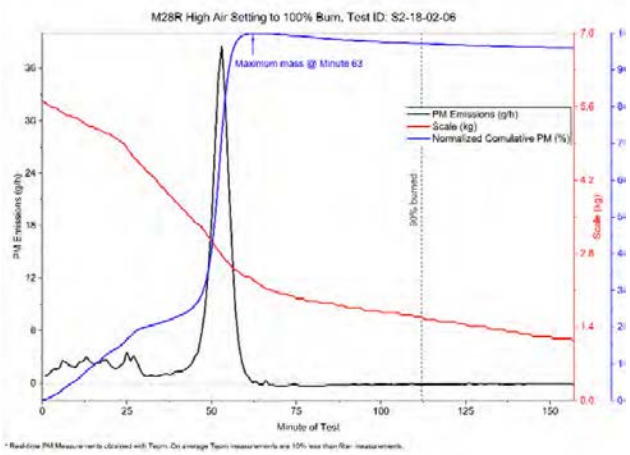
NESCAUM TEST USING IDC/ALT-140 (Dry Oak): 2019 (by NESCAUM)						
	Test Time	Dry Burn Rate Kg/hr	Total PM (g)	PM Emissions Rate (g/hr)	PM Emissions Factor (g/kg)	HHV Efficiency
	669	1.52	11.24	1.4	0.66	70.2
	657	1.54	27.37	3.3	1.62	70.2
	638	1.61	12.81	1.9	0.75	70.3
	1964			2.20	1.0	70.2
Average Emissions (3 runs) 2.2 FAILS 2.0 LIMIT						
3 runs, 3 days, 1964 Total Minutes (32.7 hours)						

EPA Disqualifies The TEOM for PM Emissions Measurement

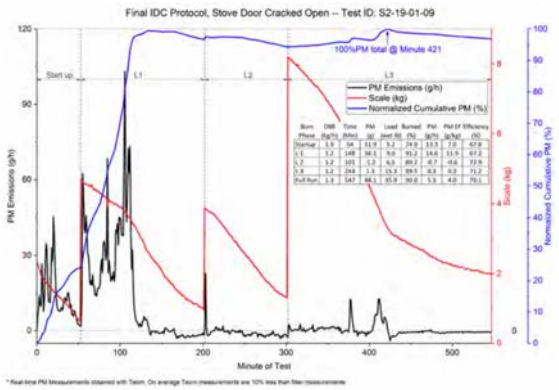
When NESCAUM first reported emissions for "Stove 7" in the "Interim Report," it reported only PM collected with a Tapered Element Oscillating Microbalance (TEOM), a device that chronically under-reports PM emissions, sometimes by as much as 30-40%. NESCAUM originally reported an emissions average of 1.63 grams an hour for "Stove 7," for the three runs in July 2018, but those results were collected using a TEOM. Results for those three runs were later corrected using an ASTM E2515 filter pull that resulted in emissions 2.37 g/hr - a 45% increase for the same three runs.

> NESCAUM describes negative TEOM emissions measurements on page 33 of the "Interim Report:" "However, as with the stove 1, the latter section of all three stove 2 baslines (sic) runs run (sic) included an extended period of zero or negative emission measurements. As discussed above, the TEOM records negative emissions when clean, hot air passing through the TEOM filter carries off the more volatile species of the PM collected earlier in the run..." (Page 33, emphasis added)

Figure 11. Stove 2—M28 Baseline Test Results



Clearly the EPA was not going to endorse a method where emissions often turned negative, like the two charts at the left for "Stove 2." In the first chart, which shows a Method 28 test, cumulative emissions (the blue line) peaks at minute 63 of a 152 minute test, and then steadily declines (i.e., sheds emissions) until the end of the test.



The second chart (left) shows a test using the IDC/ALT-140 protocol. There are several dips in the blue emissions line corresponding to the different loads in this protocol.

The two charts above show declines in the plot of real-time emissions collection using a TEOM, but they do not show the cumulative failure of the TEOM to collect PM over the duration of a run, which is an even bigger problem.

The TEOM typically understates emissions, sometimes by as much as 40%, when compared with ASTM E2515 (the current method of collecting emissions). So EPA gets some credit for figuring out that the TEOM is not a viable method for measuring PM (particulate emissions). As Steffan Johnson from EPA stated in a recent email to me:

> Our initial review of their request included an immediate rejection of the use of TEOM technology for the purposes of compliance determination; we requested that Alaska modify their request to include ASTM E2515 for the purposes of PM measurement during the testing, as the emissions standard is based on filterable PM measurement and we intended to keep it that way for the purposes of compliance with the existing rule. Note that Alaska's use of the TEOM for a one-hour emissions standard is entirely up to them; EPA has no standard for one hour emissions other than to report a measured value. Keeping the particulate measurement on par with the existing standard and using the ASTM method already referenced in the rule assures us that the measured PM emissions were collected appropriately and satisfies requirement (a) listed above as the collection and determination of PM emissions remain the same. (emphasis added)

How the TEOM Influenced the Load Protocol & Efficiency Calculation in IDC/ALT-140

So overwhelming was NESCAUM's desire to use a TEOM for PM collection, and so committed was NESCAUM to using a TEOM, that:

1. NESCAUM ended up truncating each test (to 90% of a load) to try to compensate for the obvious weakness of the TEOM (which shed emissions at the end of a load) and
2. NESCAUM also ended up trying to calculate instantaneous efficiency based on atoms of carbon, because the current method of measuring efficiency is based on an appliance burning *complete load (not 90*%). The instantaneous calculation of efficiency was its answer to "How do we calculate efficiency for multiple partial loads strung together?"

Still unresolved is how NESCAUM or EPA intends to remedy the various problems caused by "Force-Feeding" the test stove, and also how they plan to characterize and account for (i.e., measure) all of the energy in the huge coal-bed at termination of the test. There are some relatively simple ways to remedy these problems, but does EPA have the energy, creativity and drive to figure these things out? Or do they really expect manufacturers and retailers to just shrug and accept huge declines in efficiency calculations due to adoption of a new method that would put cordwood appliances at a significant (and unjustified) competitive disadvantage to, for example, pellet stoves? Stay tuned.

The IDC/ALT-140 calculation of efficiency is still a secret calculation, in that an actual calculation based on real data has yet to surface. How these calculations are averaged to come up with a single "efficiency number" (like the 77% for the Hearthstone Castleton 8031 tested with Method 28), and how NYSERDA/EPA choose to calculate the amount of emissions and energy in the terminal coal-bed are not trivial issues.

A manufacturer who chooses to test with IDCTM is likely to see the price of his products go up 26%, through loss of the Federal 26% tax credit for stoves that are over 75% HHV efficient. The IDC/ALT-140 is constructed in such a way that I don't think any woodstove tested under this method will exceed 75% efficiency – not because they aren't efficient, but simply because the test design is guaranteed to generate bad efficiency results.

The Hearthstone Castleton 8031 should be and is approved for sale in Alaska. It is a clean and efficient stove made by a reputable manufacturer. The problem here is not that the Castleton 8031 fails to achieve less than 2.0 g/hr or over 75% efficiency using IDC/ALT-140, but that the IDC/ALT-140 fails this stove, and likely will fail every stove ever tested with it. Without substantial and radical changes to IDC/ALT-140, this method is likely to be the end of cordwood testing. Maybe cordwood testing was a fool's errand to begin with.

More on "Force-Feeding" and Invalid Runs: An Obvious, Repeated but Unresolved Problem with IDC/ALT-140.

In reviewing the "Interim Report," I noticed that a majority of test runs published in the test report failed the density requirement for IDC/ATL-140. When I looked at 24 runs NESCAUM ran with maple cordwood, for example, 15 of them failed the density requirement. How this persistent problem was not recognized and/or corrected by the test developers is a mystery to me. These results are included in the "Interim Report" without any analysis.

Run	Stove#	Date Code	Time Min	Burn Rate kg/h	Emissions g/kg	Efficiency HHV	Low Burn Has Valid Density?
1	Stove 1	S1-18-08-08	531	2.92	4.58	57.3	**INVALID**
2		S1-18-08-09	523	2.82	5.37	57.1	**INVALID**
3		S1-18-08-10	569	2.72	2.59	57.7	**INVALID**
4	Stove 2	S2-18-10-23	558	1.2	6.92	65.3	**INVALID**
5	*(door cracked,*	S2-18-10-24	380	1.63	4.57	68.9	**INVALID**
6		S2-19-01-09	547	1.3	7.01	70.1	
7		S2-18-10-25	419	1.61	2.43	70.9	**INVALID**
8	(door open)	S2-19-01-07	435	1.49	5.76	69.3	**INVALID**
9		S2-19-01-08	467	1.46	6.26	70.5	**INVALID**
10	Stove 4	S4-18-10-25	320	1.38	4.3	57.3	
11		S4-18-10-26	309	1.31	5.69	57.1	**INVALID**
12		S4-18-10-27	267	1.53	3.66	CBD	**INVALID**
13	Stove 5	S5-18-08-01	475	1.4	4.16	64.5	
14		S5-18-08-02	578	1.95	1.13	64.7	
15		S5-18-08-03	507	2.22	1.58	64.4	
16	Stove 6	S6-18-07-18	535	1.91	8.39	61.4	**INVALID**
17		S6-18-07-19	510	2.08	9.65	62.3	**INVALID**
18		S6-18-07-20	558	1.91	6.35	60.4	**INVALID**
19	Stove 7	S7-18-07-25	672	1.52	1.32	70.2	
20		S7-18-07-26	647	1.49	1.12	70.2	**INVALID**
21		S7-18-07-27	661	1.47	0.84	71.3	**INVALID**
22	Stove 8	S8-19-03-06	238	3.85	1.61	60.7	
23		S8-19-03-07	253	3.69	2.58	61.1	
24		S8-19-03-08	265	3.47	2.09	60.8	

When providing data to EPA for "Stove 7," NESCAUM states that a fourth run was added (over 2 years after the initial 3 runs) to make up for an earlier mistake:

> *"The fourth maple run was performed on April 29, 2020 to obtain additional data given the missed target for reloading that occurred on Run #2." (Page 14, Supporting Data for Integrated Duty Cycle Test Method – Results from Stove 7 Testing)*

What NESCAUM fails to acknowledge is that there were TWO missed loading targets on the original 3 runs, not just one. Quoting again from the "Supporting Data" provided by NESCAUM:

> ***For Run 2 NESCAUM states****: "Three-hundred and sixty-four minutes into the test the final fuel load consisting of three large pieces and one small piece was placed in the appliance. A second small piece was prepared for this phase but could not be placed in the firebox. Fuel for this load was added from largest to smallest piece. Due to the size of the coal bed, one piece, the smallest piece, from the final fuel load would not fit in the appliance. A fuel load with a loading density of 12 lb/ft^3 was prepared but the actual fuel loading density was 10.21 lb/ft^3 due to removal of the single fuel piece." (emphasis added)*
>
> ***For Run 3 NESCAUM states****: "Three-hundred and forty-five minutes into the test the final fuel load consisting of three large pieces and two small pieces were placed in the appliance. A third small piece was prepared for this phase but could not be placed in the firebox. Fuel for this load was added from largest to smallest piece. Due to the size of the coal bed, one piece, the smallest piece, from the final fuel load would not fit in the appliance. A fuel load with a loading density of 12 lb/ft^3 was prepared but the actual fuel loading density was 10.36 lb/ft^3 due to removal of the single fuel piece." (emphasis added)*

NESCAUM tries to minimize the importance of these missed targets (by stating that it was only the "smallest piece" that wouldn't fit, or the density failure is just "due to the removal of a single piece"). However, what NESCAUM – and EPA – fail to acknowledge is that this is a recurring problem that is much bigger than a small piece not fitting in the firebox.

The bigger problem is that the overall test "force-feeds" the test stove by re-loading the stove multiple times without consuming an entire load and without removing coals or ashes, so that there is an ever-increasing coal-bed. This ever-increasing coal bed becomes a serious problem when the final (and biggest) test load is scheduled to be loaded. Not only will the final piece(s) not fit into the stove, but the large coal-bed and large load *completely fill the firebox from top to bottom*, in a way that would be inadvisable for any normal consumer.

The actual PM collection is often high on the final burn (the so-called "low" or "overnight" segment of the burn). Why is this? My hypothesis is that because the stove has

been force-fed through the previous 3 loads, that during this final segment of the burn the stove is overloaded, and wood is so close to the secondary combustion system (i.e., so high in the firebox) that it partially disables the secondary combustion system and drives up emissions. I think emissions tests are intended to measure PM during normal operation, not when the stove is abused and overloaded.

I say "my hypothesis" because no data, photographs or other records of any of these burns have ever been released. The method was developed in secret, and all of the supporting data, documents, and photographs are still secret. But the meager data available in the "Interim Report" indicates that there are serious problems that remain undisclosed. Millions of dollars of taxpayer money have been spent on the development of this test, so the secret data will eventually trickle into the public domain.

Another Stove from The "Interim Report"

"Stove 2:" Problems with IDC/ALT-140 & Bizarre Efficiency Calculations

A second stove from the "Interim Report," "Stove 2," is also on Alaska's approved list, and was originally EPA Certification Tested with Method 28. NESCAUM reports emissions using its modified Method 28 as 1.27 g/hr., but reports average efficiency for "Stove 2" as 34.36%, ***less than half of the efficiency value of 77% from its certification report.*** Something is clearly wrong with this calculation. Results like these demand that data be released and investigated, or a rational explanation be provided.

Table 15. Stove 2—Summary of the Modified M28 Baseline Test Results

	Test Time (min)		Dry-Burn Rate (kg/h)		Total PM (g)		PM Emission Rate (g/h)		PM Emission Factor (g/kg)		HHV Efficiency (%)
% Burn Completed	*90%*	*100%*	*90%*	*100%*	*90%*	*100%*	*90%*	*100%*	*90%*	*100%*	*100%*
High	112	157	1.83	1.45	5.21	5.15	2.79	1.97	1.53	1.36	31.6
Medium	135	199	1.52	1.15	3.64	3.60	1.61	1.09	1.06	0.94	28.5
Low	138	200	1.51	1.15	2.61	2.58	1.13	0.77	0.75	0.67	43.0

???

Please help me. The chart above is from page 32 of the "Interim Report." The HHV Efficiency numbers in the right hand column are a joke. "Stove 2" was EPA certified, using

Method 28, with an efficiency of 77% HHV. The above average is 34.36%. Am I supposed to take this seriously?

All parties to the NSPS and the various proposed test protocols have stated publicly that efficiency calculations are important to the public at large. I haven't seen efficiency calculations this anomalous in decades

NESCAUM also tests the "Stove 2" using the IDC/ALT-140. A 3 run battery of tests in 2018 produced an emissions average of 15.37 g/hr, and a second 3 run battery of tests in 2019 produced an average 6.63 g/hr. These two results vary by more than 100%, and they are 5x to 12x greater than NESCAUM's own M28 value (1.27 g/hr.), and **over 40x the original EPA certification test value of 0.3 g/hr.** To further complicate the matter, 5 of 6 IDCTM runs are invalid because the load density was too low. Had they loaded the correct amount of wood, results undoubtedly would have been worse. I'm sure some people would blame these results on the stove (and in fact they do, as noted below), but the problem is elsewhere.

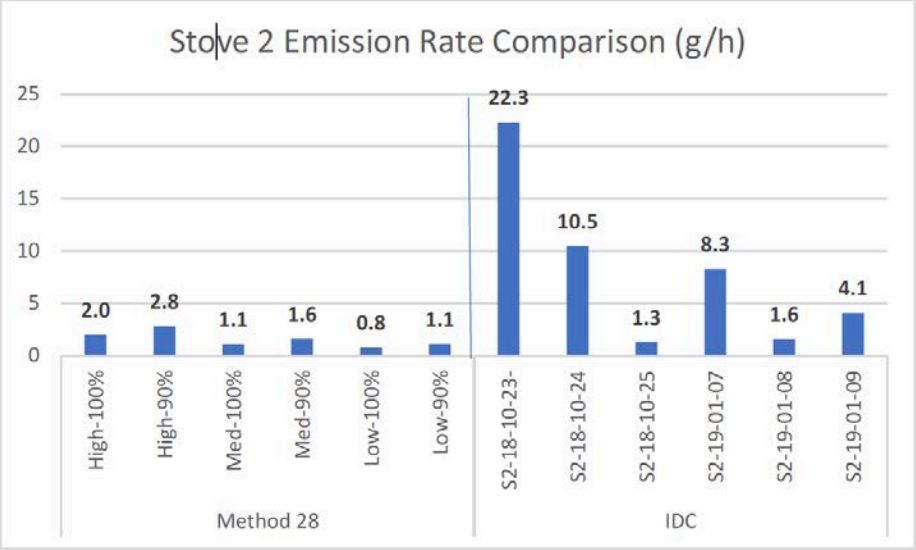
"Stove 2:" More Efficiency Calculation Problems with IDC/ALT-140

Again, "Stove 2" qualifies for the 26% tax credit with its certification efficiency of 77% HHV and likely well deserves to be on the Alaska approved list, which it is. However, the three 2018 IDCTM tests on "Stove 2" yield an efficiency of 68.4%, and the three IDCTM tests in 2019 yield an efficiency 69.97%. These two sets of test results have efficiencies nearly double NESCAUM's insanely incorrect "Modified M28" results, but all these results would still disqualify this stove for the 26% federal tax credit (which is, by the way, available to current residents of Fairbanks, AK if they choose to install this stove).

The discrepancies both between a) the EPA Certification Test results, b) NESCAUM's Method 28 Results, and the c) IDC/ALT-140 tests, as well as the difference between the two NESCAUM IDC/ALT-140 emissions tests, clearly need to be reviewed and analyzed. The IDC/ALT-140 also needs to be carefully reviewed. It is not credible that ADEC and NESCAUM are unaware of these inconsistencies.

The discussion of the "Stove 2" test results in the "Interim Report" includes this chart, which shows NESCAUM's low emissions using Method 28 on the left, and its erratic results using IDC/ALT-140 on the right.

Figure 18. Stove 2-Comparison of Method 28 and IDC Emission Rate Measurement



In discussing the obvious and significant differences in emissions for "Stove 2," the "Interim Report" in part blames the stove, saying it just "does not burn consistently, even with a standardized fueling protocol" see full quote below) all the while ***ignoring that five of six runs conducted with that "standardized fueling protocol" were invalid they violated the test protocol!***

> "The reason for the differences in the temperature profiles is less clear.... While each set of IDC stove 2 tests was run on sequential days, there were approximately 12 weeks between the two sets of runs. This space of time introduces the potential for other variations in operation. However, except for the first run in the first group, which was different from all other runs in both groups, there was no clear difference between the range of temperatures or emission profiles and the first and second group of runs. **What is very clear, however, is that stove 2 does not burn consistently, even with a standardized fueling protocol**, and that differences in the stove temperature profile have a strong impact on the effectiveness of the catalytic control system. ("Interim Report" page 47, emphasis added)

The "Interim Report" also claims that the Method 28 Tests performed better because

the M28 tests started with wood placed on a hot coal-bed.

> However, as shown in that figure, the ERs measured using M28, the current EPA protocol, were considerably lower than those measured in four of the six IDC runs. Because M28 is a hot-to-hot method (measurements start after a bed of hot coals has been generated), the stove temperature at the start of the M28 runs (442–472°F) were already substantially above the 300°F temperature that appears to be required for the catalytic control system to ignite " ("Interim Report," pg 49, emphasis added. See chart on previous page for reference.)

What the author of the "Interim Report" politely ignores is 1) that the worst emissions in the IDC/ALT-140 tests occurred when placing new loads on hot coal-beds (in the high and medium burns), 2) that the structure of the test itself (force-feeding a stove as described above) is not representative use, and 3) that five of six IDCTM runs failed the density requirement because calculated loads wouldn't fit in the stove, *as a result of the "force feeding" protocol.* Put simply, this is another example where the test protocol itself is a failure. Otherwise, Alaska wouldn't have this stove on its approved list. Right?

Summary

In this Review I have discussed the oddity of ADEC submitting the "Interim Report" and "Stove 7" data to EPA in support of IDC/ALT-140, when in fact "Stove 7" fails to pass the current emission standard with IDC/ALT-140. Further, there is no evidence that any stove has or will pass the IDC/ALT-140 standard as it currently stands in its "approved" form.

Also reviewed is the problem with the "Force-Feeding" protocol in IDC/ALT-140, and the failure of the test developers to meet their own density requirements as a result of this "force-feeding" protocol. The force-feeing protocol is not just inconsistent with normal use, but it is also a dangerous way to operate a stove, and likely violates EPA's own "Burn Wise" program. This protocol needs serious scrutiny.

The variability and nonsensical nature of efficiencies reported in the "Interim Report" are additional serious problems that need to be addressed before anyone actually attempts to test an appliance with this method. At my own company, we take efficiency seriously, and we have worked hard to design high efficiency stoves. We do not intend to

sacrifice our hard work to a new efficiency calculation that is arbitrary, capricious, and clearly not based on sound engineering judgment, as evidenced by the results included in the "Interim Report," some of which are discussed above.

Finally, there is a problem with secrecy and the withholding of basic data, as well as the test developers ignoring some painfully obvious problems, like repeatedly failing to meet their own density requirements, producing utterly nonsensical efficiency numbers, and trying to "work-around" the obvious limitations of the TEOM. Ignoring these issues is just another form of secrecy. Or falsity.

When Richard Wayland states in his December 21, 2021 MEMORANDUM that ALT-140 is "available to all parties" as a compliance testing option, the word "available" is probably an apt description, and the best he can do. Like a car with 4 flat tires, it might be "available," but it can't be used in its current condition.