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December 15, 2011 (via email)

Ms. Abigail Daken
Energy Star Product Development Team
US Environmental Protection Agency
1200 Pennsylvania Avenue NW (Postal Code 6202J)
Washington DC 20460

Re: Proposal to add Boilers to "Most Efficient" pilot program

Dear Ms. Daken,

As a manufacturer of a full line of residential boilers, Crown has several models that would be eligible to participate in the Energy Star (ES) Most Efficient (ME) pilot program for boilers. Despite this, Crown believes that the addition of boilers to the ME program is bad for our industry, the Energy Star brand and the consumer. Our reasons for this can be summarized as follows:

- The "real world" AFUE for the type of boiler that would be eligible for this program is highly dependent upon the system in which it is installed. This violates EPAs own requirement that ME recognized products deliver top performance regardless of where they are installed.
- It is debatable whether there is *any* cost, or even environmental, benefit to the use of the boilers that would be eligible for this program.
- As presented, the scope for this program is flawed and could encourage the use of unproven, and potentially unsafe, technology.

Impact of System on Boiler Energy Consumption

During the November 30th Webinar, EPA indicated that one of the requirements for a product's inclusion in the ES ME program is that "recognized products deliver top performance regardless of geography/climate". EPA further indicated that this requirement is intended to help protect the credibility of the ES brand. We agree with EPA's requirement with respect to climate and geographical location, but would also suggest that products having system-dependent energy descriptors (like boiler AFUE) pose an equal threat to the ES brand. In the case of boilers, this is especially true for the "Most Efficient" program, where the recognition criteria specify an AFUE level that implicitly requires flue gas condensation.

The most obvious way in which the system design impacts boiler energy consumption is the effect that water temperature has on the efficiency of condensing boilers. Boiler AFUE's are obtained with the water entering the heat exchanger at approximately 120F. A typical flue gas dew point for a natural gas condensing boiler is approximately 130F, depending on the air-fuel ratio. The return water temperature in a hot water heating system may be as low as 80F or as high as 200F with the actual temperature at a given heating load largely a function of the system design. When a conventional condensing boiler is subjected to a return water temperature higher than the dew point of the flue gases, no latent heat recovery can be expected. For a natural gas boiler, this condition immediately sets a ceiling on the achievable <u>steady-state combustion efficiency</u> of 90.45%. The actual operating efficiency may be significantly lower when sensible and off-cycle losses are subtracted. It is important to understand that *the more an AFUE is dependent upon latent heat recovery, the more the "actual" AFUE will drop as the return water temperature rises past the* *dew point*. For this reason, it theoretically possible to have two boilers with 89, and 96% AFUEs when tested in accordance with 10 CFR430 (120F return temp) that would have identical AFUEs if this test was to be performed at a slightly higher return water temperature.

There are other system variables that impact the energy consumption of a boiler. A system with a higher water flow and/or pressure drop requirements will require a pump having greater power consumption. Likewise, installer-supplied electrical components, such as additional pumps, zone controls, and draft inducers may have a collective power consumption that is in excess of that for the boiler itself. These system variables are not captured by the primary boiler energy descriptor (AFUE) used by the ES program, nor should they be; the manufacturer has little or no control over them. With that said, EPA needs to recognize that, while AFUE is a good way to compare the relative efficiency of two different boilers installed in identical systems with 120F entering water temperature, it is a less reliable predictor of boiler performance in a specific home than are energy descriptors used for "stand-alone" appliances, such as refrigerators and washing machines.

We recognize that system variables may also impact the energy performance of other HVAC products in other ES categories, but doubt that they do to the same degree as for boilers. For example, residential furnaces receive return air at a temperature which is essentially the same (that of the room air), and well below the dew point of the flue gasses in the furnace heat exchanger, regardless of the system in which they are installed. Field-supplied electrical components, such as zoning controls, are also less common in residential forced air systems than they are in hot water systems.

Economic and Environmental Costs of Condensing Boilers

While we agree with EPA that some consumers may want to select ME products because they are good for the environment even when they do not necessarily reduce operating costs, we also think that maintaining the credibility of the ES brand demands that such products not *increase* operating costs. Attachment #1 is a copy of a cost-benefit analysis comparing two pairs of condensing and non-condensing boilers. This analysis is the same as that sent to you in August except for minor cosmetic changes and the removal of specific model numbers.

Both condensing boilers shown in this analysis have AFUEs that are close to the threshold for eligibility in the ME program (95.0%). Both non-condensing boilers have AFUEs that are close to the impending DOE minimum for gas hot water boilers (82.0%). Obviously, the incremental benefit of the ME boilers will be less than that shown (or non-existent) if the AFUE of the non-condensing boilers are higher. Also, for the reasons discussed above, the difference between operating costs for the two types of boilers can be expected to be even less than that shown when the return water temperature is above the dew point of the flue gas. As can be seen from this analysis, both condensing boilers do provide some reduction in annual energy costs relative to their non-condensing counterparts before depreciation and maintenance is considered. When these factors are included, however, the smaller condensing boiler actually has a *higher* annual operating cost than its non-condensing counterpart. When the same costs are considered on the larger boilers, the payback period for choosing the condensing boiler is 37.4 years - more than twice its anticipated life expectancy.

Certainly, the exact life expectancies used in this analysis can be debated, but there is at least some independent support for the values used (manufacturer's warranties are one source). Attachment #2 is an article that appeared on the British website ThisisMoney.co.uk earlier this year and which supports our contention that condensing boilers generally have both a shorter life expectancy and higher maintenance cost than non-condensing boilers. The significantly shorter life expectancy of condensing boilers has environmental implications of its own, as these boilers can eventually be expected to enter the waste stream at a higher rate than non-condensing boilers (and create additional demand for the energy and resources required to replace them).

In short, we believe that there are many cases where a ME boiler may actually cost the consumer *more* to operate than a boiler that is completely outside of *any* ES program while providing no real environmental benefit when the shorter life expectancy, and additional maintenance requirements, for the ME boiler are considered. It follows that inclusion of boilers in the ME program poses a clear threat to the integrity of the ES brand.

Flaws in "Most Efficient" Boiler Scope

We have two concerns about the wording of the ME boiler scope itself:

- It appears to allow the inclusion of appliances other than boilers in the ME category for boilers.
- During the November 30th teleconference, EPA indicated that oil boilers are included within this scope, even though the scope itself indicates that they are not. We believe that condensing oil boiler technology is "emerging" in the US marketplace and that such products therefore do not meet EPAs guidelines for inclusion in the ME program.

In the US, there are several safety standards that are applied to boilers. These include ASME Section IV, which governs the design and construction of the boiler with a heavy focus on preventing explosion hazards. Gas boilers are also certified to ANSI Z21.13, which addresses this and other hazards potentially presented by an improperly designed or constructed boiler (carbon monoxide, fire, electrocution, etc). By including "heating units" within this scope, EPA is encouraging the use of equipment that may never have been designed for use in space heating applications and/or which has never been evaluated to generally accepted US safety standards for boilers. If a "heating unit" is certified as being in accordance with these safety standards, it can sold as a "boiler" and not as a "heating unit". This is true even if the boiler is also used for domestic hot water production or for other non-space heating applications.

There are currently two brands of residential condensing oil boilers in the US marketplace. Both are imported from Europe and both have only been sold here for a few years. Condensing oil boilers have a longer field history in Europe, but sulfur levels in the fuel used there are generally lower than in the US. This has significant implications for the durability, long term efficiency, and reliability of these products in this marketplace. We submit that this means condensing boilers are "emerging technology" (to the left of the "chasm" mentioned in the November 30th teleconference) in the US and are therefore ineligible for inclusion in the ME program.

Other Comments

Some of the arguments presented above also apply to the validity of the "original" ES program for boilers, which currently has a specification of 85.0% AFUE. We know that EPA is tasked with adjusting the specification for ES programs so that the market share of ES products in a given category remains at about 35%. Given a choice of raising the current 85.0% specification, or removing boilers from the Energy Star program completely, we believe that the latter option is appropriate.

Please do not hesitate to contact me if I may answer any questions or provide additional information.

Sincerely,

Yale Steingard
President

Attachment #1

	Case 1: Design Heating Requirement=78000 BTU/hr		Case 2: Design Heating Requirement=132000 BTU/hr		
Boiler Type	Non-condensing	Condensing	Non-condensing	Condensing	Ref #
Boiler AFUE	82.3	94.5	81.7	95.2	1
Boiler Gross Output (BTU/hr)	78000	80000	137000	132000	1
Initial Cost To Consumer:					
Boiler	1626	3164	2007	3690	3
Labor & Other Materials	1549	4061	1549	4061	4
Total	3175	7225	3556	7751	2
Incremental Cost of Condensing Boiler		4050		4195	
Annual Fuel Usage (Ef)(MMBTU/yr)	97	84	156	134	1
Annual Electrical Usage (EAE) (kW-hr/year)	164	155	155	147	1
Average Cost of Natural Gas ($/Therm)	1.1011	1.1011	1.1011	1.1011	5
Average Cost of Electricity ($/kW-hr)	0.1165	0.1165	0.1165	0.1165	5
Heating Load Hours (hr)	2250	2250	2250	2250	6
Design Heating Requirement (BTU/hr)	78000	78000	132000	132000	7
Rated Design Heating Requirement (BTU/hr)	50000	50000	80000	80000	8
Adjustment Factor	1.6875	1.6875	1.7849	1.7849	9
EAFU (MMBTU/yr)	163.6875	141.75	278.4375	239.170673	10
EAEU (kW-hr/yr)	276.75	261.5625	276.6526	262.3738	11
Annual Fuel cost	1802.36	1560.81	3065.88	2633.51	12
Annual Electrical Cost	32.24	30.47	32.23	30.57	12
Total Energy Cost	1834.60	1591.28	3098.11	2664.07	
Annual Energy Savings over Non-Condensing Boiler		243.32		434.03	
Payback Period Before Maintenance/Depreciation(years)		16.6		9.7	
Boiler Life Expectancy (years)	35	15	35	15	13
Depreciation Cost	46.46	210.93	57.34	246.00	
Annual Maintenance	66.67	200.00	66.67	200.00	14
Total Annual Operating cost	1947.73	2002.21	3222.12	3110.07	
Payback Period After Maintenance/Depreciation(years)		-74.3		37.4	

References

1) AHRI Directory

2) Installed costs for smaller boilers is averaged value provided by three contractors in the northeastern US. Installed costs for larger boilers are based on assumption that "labor and other material" cost is independent of boiler size. Installed cost for larger boilers is therefore calculated using same "labor and other material" costs as for smaller boilers and adding homeowner's cost for boiler (3)

3) Boiler cost to homeowner calculated by applying standard discounts to trade ("list") price and then applying typical mark-ups for wholesaler and contractor.

4) For smaller boilers: Reference (2) - Reference (3). For larger boilers: assumed same as for smaller boilers

5) Representative Average Unit Costs of Energy, 3/10/11 Federal Register.

6) January 1, 2010 GAMA Directory, Chapter 1, Figure 1 (Mid Atlantic Region)

7) Smaller Gross Output for each pair of boilers

8) January 1, 2010 GAMA Directory, Chapter 1, Table 1

9) January 1, 2010 GAMA Directory, Chapter 1, Procedure for Estimating the Annual Heating Requirements and Comparing the Cost of Operation of Different Models, Step 5

10) January 1, 2010 GAMA Directory, Chapter 1, Procedure for Estimating the Annual Heating Requirements and Comparing the Cost of Operation of Different Models, Step 6

11) January 1, 2010 GAMA Directory, Chapter 1, Procedure for Estimating the Annual Heating Requirements and Comparing the Cost of Operation of Different Models, Step 7

12) January 1, 2010 GAMA Directory, Chapter 1, Procedure for Estimating the Annual Heating Requirements and Comparing the Cost of Operation of Different Models, Step 8

13) For non-condensing boilers - Median life expectancy for cast iron boilers from 1995 AHSRAE Applications Handbook, Chapter 33, Table 3. Life expectancy for condensing boilers based on discussions with various European boiler manufacturers. The latter value can be confirmed by inspection of warranties for various condensing boilers.

14) Assumes one annual $200 service/maintenance visit for the condensing boiler and a similar visit for the non-condensing boiler every three years. Relative maintenance costs will probably be higher for the condensing boiler.

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Are condensing boilers a waste of money?

By This Is Money

Last updated at 4:44 PM on 5th January 2011

Five years ago, they were heralded as the modern, clean and green way to heat your house. As a result, today there are already eight million 'condensing boilers' in homes across Britain.

Con-dense: Modern boilers may not be as efficient as first thought.

In fact, since 2005 it is illegal to fit any other kind.

At the time, the Government claimed they would massively reduce your carbon footprint and slash your fuel bills. As a result, every year some 1.2m old-style 'dirty' boilers are scrapped in Britain and replaced by this wondrous new variety.

However, the recent cold snap has revealed a major problem with them. Tens of thousands of people found themselves shivering as their shiny new boilers cut out without warning.

British Gas is understood to have had 60,000 call-outs in Yorkshire alone. And the cost to call out a plumber? It can be between £200 to £300 on a bank holiday. And don't forget about VAT.

'We've had double the number of call-outs as in the same period last year,' says Charlie Mullins, MD of Pimlico Plumbers in London, the country's largest independent plumbing company.

'It is a massive problem. Some customers were ready to move out because their condensing boilers broke. If I had a choice, I'd put in a non-condensing boiler every time.'

It's all the more infuriating because the problem causing these breakdowns is so simple. In cold weather, the pipe that takes waste water from the back of the condensing boiler — which isn't there in a normal boiler — freezes solid, shutting down the system and in many cases causing permanent damage.

Forums: 'My condensing boiler problem and the advice I was given'

But this problem is just one of many that have plagued this boiler design since they became popular in the Nineties. Many plumbers consider them to be little more than a multi-billion pound con-trick.

In a regular boiler, the hot gases produced when the methane fuel is burned heat water for your radiators, dishwasher, taps and so on. But about 25% of the heat vents out of the exhaust pipe in the form of hot steam and CO_2.

Advice: Jo Thornhill explains how to protect your house from a harsh winter

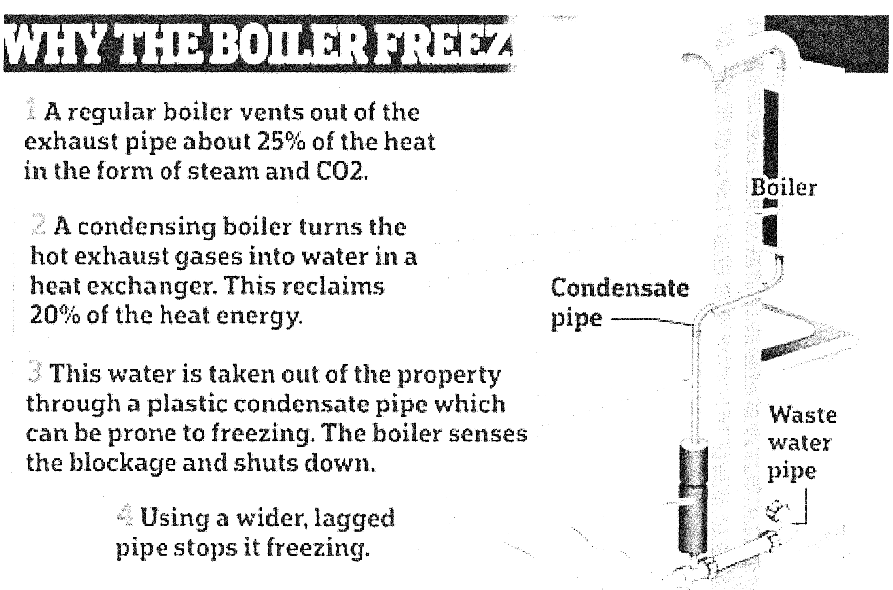
In a condensing boiler, a condenser claws back much of the lost heat because as steam condenses into water, it feeds heat back into the system. This can increase overall efficiency from 75% to as much as 93%, and reduce CO_2 emissions — and your bills — by a commensurate amount. That, anyway, is the theory boilermakers and politicians want you to believe.

In 2005, the then-deputy PM John Prescott drew up a masterplan to help Britain meet its CO_2 emissions targets, as dictated by the 1997 Kyoto Protocol. This involved a new law ordering that all new and replacement boilers fitted to British homes — some 1.4m annually — must from that date be of the condensing type.

A 'boiler scrappage' scheme followed in 2008, which offered people £400 towards the cost of a new condensing boiler if they replaced their old one — even if it was in perfect working order. Boiler manufacturers and plumbing and installation firms could hardly believe their luck.

An estimated eight million homes in Britain made the switch, often encouraged by persistent salesmen who produced an impressive-looking audit offering a seductive assessment of how much money you could save by switching to a new, 'clean' boiler.

But even ignoring the freezing pipe problem, it is clear that in most cases it makes no economic sense to scrap an old boiler that is still functioning.



For an average home, replacing even a very inefficient old model with the best new boiler on the market will, at most, save a couple of hundred pounds a year in gas bills. That sounds good until you realise that at £2,000 for one of the better condensing models, a new one will take at least ten years to pay for itself.

And the problem is that these boilers simply do not last anything like ten years.

'You might get 20 years out of one of the old ones,' Charlie Mullins says, 'but it is more like three to six years out of one of these new ones. In fact, if it goes wrong after four years, you are better off replacing a condensing boiler altogether because of the horrendous cost of the parts.

'On the basis of efficiency, they certainly do not pay for themselves. It makes no sense to take out a working old boiler and replace it with a condensing one.'

That's not something the enthusiastic salesmen will tell you. They also won't tell you that those touted increases in efficiency are theoretical, often not matched in reality. These boilers rarely operate at maximum efficiency anyway.

Explained simply, the water returning from your radiators back to the boiler has to be below 55c for the condenser to condense the steam in the boiler into water. For most homes using standard radiators, this will probably not be the case — the returning water might be as hot as 65c, especially when the radiators are turned up in cold weather.

One impractical 'fix' would be to fit oversized radiators, which can warm the room to the same degree despite being slightly cooler. Another solution would be to fit the latest radiant heating technologies, using pipes embedded in walls and floors.

But fitting these hi-tech systems, which are fairly common on the Continent but rare in Britain, would cost thousands of pounds for most homes.

The problems don't stop there either. The condensed water vapour produced in the new boilers is slightly acidic (as it contains dissolved nitrogen and sulphur oxides), which inevitably causes corrosion of the delicate boiler components and also leads to breakdowns.

So the message is clear: if you have an old boiler, provided it is working properly and is serviced regularly, you are almost certainly better off keeping it until it is beyond economic repair. Parts will be cheaper, it will be less likely to break down and there is no danger of it stalling on the coldest night of the year.

If you're worried about your carbon footprint, just remember that the touted efficiency savings are theoretical figures and might not reflect reality. In a well-designed, well-insulated new home that incorporates the latest heating technology, a condensing boiler might be more efficient.

But most of us do not live in such homes — we have poor insulation and ageing pipes and radiators. Remember, also, that manufacturing each new boiler has a 'carbon cost' in itself that must be 'paid back' by the new boiler.

There is no doubt that the great switch to condensing boilers was motivated by the best intentions. But that's small consolation if you find yourself shivering in a freezing house this winter, wondering when the plumber is going to arrive.