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AHRI Air-Conditioning, Heating, and Refrigeration Institute

July 30, 2012

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
Mailstop EE-2J
1000 Independence Avenue, SW
Washington, DC 20585-0121

Re: Notice of Proposed Rulemaking – Test Procedures for Residential Furnace Fans [Docket No. EERE–2010–BT–TP–0010/RIN 1904–AC21]

Dear Ms. Edwards:

These comments are submitted by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) in response to the U.S. Department of Energy's (DOE) notice of proposed rulemaking (NOPR) appearing in the Federal Register on May 15, 2012. The NOPR pertains to the test procedures for residential furnace fans.

AHRI is the trade association representing manufacturers of heating, cooling, water heating, and commercial refrigeration equipment. More than 300 members strong, AHRI is an internationally recognized advocate for the industry, and develops standards for and certifies the performance of many of the products manufactured by our members. In North America, the annual output of the HVACR industry is worth more than $20 billion. In the United States alone, our members employ approximately 130,000 people, and support some 800,000 dealers, contractors and technicians.

This rulemaking is of great importance to AHRI members. In general, we believe that significant changes are necessary to the proposed test procedure in order to ensure that the original intent of the Energy Policy and Conservation Act (EPCA) is fulfilled and that the testing burden imposed on manufacturers is minimal. We have reviewed the NOPR and have the following specific comments:

Section 1 – DOE Interpretation of 42 USC § 6295

The test procedure NOPR for residential furnace fans indicates that the intended scope of coverage includes furnace fans found in a variety of residential central HVAC products. The NOPR states that furnace fans include, but are not limited to, the air distribution fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, modular blowers, and hydronic air handlers. We disagree with this expanded scope on the basis that it has misinterpreted the relevant provision of EPCA. The heading of 42 USC § 6295(f) is "Standards for furnaces and boilers" and subsections 1 through 4 under that section apply to only residential furnaces and boilers, as defined by EPCA. This clear, consistent format combined with the fact that the requirement for a standard covering electricity used to circulate air through duct work was inserted as 4(D) under 42 USC § 6295(f), strongly indicates that the scope of this requirement is only motor and blower combinations provided on residential warm air furnaces, otherwise referred to as furnace fans. There is nothing within section 42 USC § 6295(f) that suggests that the provisions of that section apply to any other products that may be used to heat a residence.

There are several other related circumstances that reinforce this point. In the case of residential heating and cooling equipment that use electricity as the primary energy supply, the applicable efficiency descriptor accounts for the electricity consumed by the fan used to circulate the conditioned air. The corresponding DOE test procedure appropriately accounts for the fan energy consumption in calculating the heating and cooling efficiencies. However, in the case of residential furnaces, the annual fuel utilization efficiency (AFUE), by definition, includes only the gas or oil consumption. Currently, the DOE efficiency test procedure for furnaces does not account for the furnace fan energy consumption. Furthermore, the average annual auxiliary electrical energy consumption, E_{AE}, is currently measured as a total of all electric components and the specific energy consumption of the furnace fan is not distinctly captured within the metric. Thus paragraph (D) was added to 42 USC § 6295(f)(4) to address that shortcoming of the regulations covering furnace energy efficiency.

As significant is what was not done when this paragraph was added. If the intent of this change had been to include residential air conditioners and heat pumps, then a corresponding paragraph would have been added to 42 USC § 6295(d) – the section covering central air conditioners and heat pumps to address test procedure changes to isolate the fan energy consumption. The fact that this was not done clearly acknowledges that the efficiency descriptors for air conditioners and heat pumps already account for the fan electricity consumption. Hence, unlike furnaces which require a new standard to cover fan efficiency or energy consumption, metrics like Seasonal Energy Efficiency Ratio (SEER) and Heating Seasonal Performance Factor (HSPF) already address fan energy consumption in air conditioners and heat pumps respectively.

In the case of modular blowers and hydronic air handlers, the equipment is not currently a federally regulated product. If 42 USC § 6295(f)(4)(D) was intended to cover this equipment, then there would have been a corresponding change to the definition of furnace or the addition of this product class along with a direction to develop a corresponding test procedure. The absence of any such legislative change contradicts the NOPR's assertion that it also covers modular blowers.

The legislation authorizes DOE to include only the following products for the rulemaking on furnace fans: forced air weatherized and non-weatherized central furnaces using single-phase electric current or DC and with a heat input rate less than 225,000 Btu/h, and electrical furnaces (as defined in 10 CFR Part 430.2). As we noted earlier, the electrical consumption of fans associated with residential HVAC products like split systems, packaged central air conditioner and heat pump air handlers are already addressed in descriptors like SEER and HSPF. These products are currently regulated, and including them in the residential furnace fans rulemaking would cause these HVAC systems to be regulated twice. Other products such as modular blowers, small-duct, high-velocity systems, through-the-wall systems and hydronic air handlers should also be excluded from the scope of this rulemaking since they are not identified in the legislation that directed DOE to develop this regulation.

<u>Section 2 – Fan Efficiency Rating</u>

We are concerned with the significant burden that the proposed fan efficiency rating (FER) will impose on the industry. We applaud DOE for developing a furnace fan test procedure in a timely manner, but we believe that the following modifications are required to the conditions that lead to the calculation of the proposed FER metric:

1. The furnace should be set up at maximum speed and weighted average external static pressure (ESP) on the test stand that is used to measure AFUE. The furnace should be operated in the heating mode only. Temperature rise and power should be measured. Measurements should be taken at nominal voltage and no voltage adjustments should be allowed.
2. Airflow should be calculated based on the results generated in step 1.
3. Without changing the duct restriction in any way or firing the furnace, the furnace should be set at the heating airflow settings and the power should be measured.
4. Without changing the duct restriction in any way or firing the furnace, the furnace should be set at the circulation airflow setting and the power should be measured.

We are in the process of incorporating these modifications into DOE's proposed furnace fan test procedure. We anticipate submitting the revised draft test procedure to DOE for consideration by the end of August 2012. The benefits of the test procedure modifications proposed above are:

- Significant reduction in testing burden while providing the same qualitative benefits to consumers as the FER metric in DOE's proposed test procedure.. Manufacturers will experience labor savings with respect to conducting tests and calculations. No additional test equipment will be required beyond the equipment that is used to conduct the test method specified in Appendix N to Subpart B of Part 430 of Title 10 – Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers. The reduction in testing burden though the adoption of the proposed modifications to the FER metric would be in the order of 80-90%.Elimination of issues related to the differences between ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 and ANSI/ASHRAE Standard 37-2005. The differences between the two standards are explained further in Section 3 of this letter.
- Elimination of potentially inaccurate assumptions from the system reference curves while keeping intact DOE's proposed field ESP conditions.
- Continued use of DOE's recommended annual operating hours for calculating FER.
- The quadratic curves in the proposed test procedure can be easily manipulated. Furthermore, they can be significantly skewed through a single incorrect measurement. The proposed test procedure modifications will help eliminate the potential issues associated with the quadratic curves.

<u>Section 3 – ANSI/ASHRAE Standard 37-2005 versus ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07</u>

If DOE does not exclude central air conditioners and heat pumps from the scope of this rulemaking as recommended in Section 1 of this letter, we believe that DOE needs to re-examine the standards that are referenced in the test procedure NOPR for furnace fans. Using only ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 to measure fan performance is not appropriate. We strongly believe t that DOE should also consider ANSI/ASHRAE Standard 37-2005, *Methods of Testing for Rating Unitary Air-Conditioning and Heat Pump Equipment* for airflow measurement if residential central air conditioners and heat pumps.

<u>Configuration</u>

ANSI/ASHRAE Standard 37-2005 specifies the standard configuration for refrigeration cooling and heating tests. The option of an inlet duct or a freely open unit return to the ambient is permitted. Static pressure is measured across the supply and return and if no duct is used on the return, the information associated with the ambient conditions of the laboratory is used. In contrast, ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 provides several different configurations. DOE may be looking into the use of the multiple nozzle approach. Figure 10a in ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 shows the use of multiple nozzles. Such a setup for residential central air conditioners and heat pumps is not consistent with current industry practice of using a duct specified in ANSI/ASHRAE Standard 37-2005 to measure static pressure. Figure 10a in ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 includes a cell straightener within the duct and a transition piece prior to the PL.4 measurement plane, Figure 10b has similar problems in that a star straightener and a transition piece are used prior to the PL.4 measurement plane, while Figure 10c includes a common part and a transition duct prior to the PL.4 measurement plane. It is physically impossible for the static pressure measured at PL.4 to be the same as the static pressure measured using the ANSI/ASHRAE Standard 37-2005 duct with no cell straightener and transition piece. Figure 12 in ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 shows that the static pressure is measured at PL.7 – a location that follows a duct of unknown dimension feeding into an abrupt cross sectional area change. This geometry is different from the one specified in ANSI/ASHRAE Standard 37-2005. Figure 15 shows a blow through configuration whereas the ANSI/ASHRAE Standard 37-2005 does not use this type of configuration. The location of the PL.8 measurement plane is different and inconsistent with ANSI/ASHRAE Standard 37-2005.

There are no other setup diagrams in ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07. Hence, the two standards are incompatible from a geometry perspective and any new certification based on ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 will require manufacturers to create a new setup. All testing required under the proposed furnace fan test procedure would have to be new and will not be compatible with the required test method for generating the SEER and HSPF ratings.

Airflow Calculation Differences

Although the multi nozzle chamber specifications are the same in both ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 and ANSI/ASHRAE Standard 37-2005, the calculations to determine the actual airflow are quite different. ANSI/ASHRAE Standard 37-2005 refers to the ASHRAE handbook on fundamentals for air properties whereas ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 determines air density using the air density calculation specified in section 7.2.1 of the standard. Although the dynamic viscosity calculations are the same in both standards, the Reynolds number equations are different due to the fact that ANSI/ASHRAE Standard 37-2005 uses a discharge coefficient whereas ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 uses an expansion factor in addition to the discharge coefficient. Lastly, the pressure measurement locations specified in the two standards are different and can lead to 1 – 3 inH_2O difference in the pressures that are eventually used in the airflow calculations. ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 uses the pressure entering the nozzle while ANSI/ASHRAE Standard 37-2005 uses the nozzle throat pressure for cubic feet per minute (CFM) calculations.

Standard Air

The definitions of standard air in the two standards are not compatible. ANSI/ASHRAE Standard 37-2005 defines standard air as dry air having a mass density of 1.204 kg/m^3 (0.075 lbm/ft^3) whereas ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 has the following definition:

3.1.12 Standard air: Air with a standard density of 1.2 kg/m^3 (0.075 lbm/ft^3) at a standard barometric pressure of 101.325 kPa (29.92 in. Hg).

3.1.12.1 Standard air properties. Standard air has a ratio of specific heats of 1.4 and a viscosity of 1.8185 x 10^{-3} Pa●s (1.222 x 10^{-5} lbm/ft●s). Air at 20°C (68°F) temperature, 50% relative humidity, and standard barometric pressure has the properties of standard air, approximately.

At 68°F dry bulb temperature, 50% relative humidity and 1 atmosphere, the standard air density is 0.0743 lbm/ft^3. At 10% relative humidity, the standard air density is 0.07499 lbm/ft^3. This means if the standard air is corrected per section 3.1.12, one will get an answer that is about 1% different than the ANSI/ASHRAE Standard 37-2005. If the standard air is corrected to 68°F dry bulb temperature, 50% relative humidity and 1 atmosphere, one would get an answer about 2% different than the ANSI/ASHRAE Standard 37-2005.

ANSI/ASHRAE Standard 37-2005 is precise and is effectively a mass flow equivalent. The precision is required for heat transfer calculations. The standard refers to dry air which is well defined. Furnaces are often used in conjunction with the ANSI/ASHRAE Standard 37-2005 method of test. It is unreasonable to have two different values of airflow reported for the same equipment and application.

Based on the issues raised above, we recommend that DOE allow manufacturers to use ANSI/ASHRAE Standard 37-2005 with regards to configuration, airflow calculation and the definition of standard air.

Section 4 – Issues on Which DOE Seeks Comment

1. Airflow Control Setting Function Designations

The maximum airflow-control setting on a furnace is often referred to as the cooling speed. This reference may be misinterpreted to mean that it is the only cooling speed. It is commonly understood that it is the highest airflow rate that a particular furnace can supply. If the furnace has multiple fan speeds, it is understood that additional lower "cooling speeds" are available on each additional fan speed. The assumption that the cooling speed will be the highest speed is a worst case assumption.

The low airflow-control setting is most likely default constant-circulation setting. However, a product's electronic control system would be the interface for operating the constant-circulating setting regardless of the number of airflow-control settings that are available on the motor. If the case exists where the appliance controls the constant-circulation setting to be the same as the heating setting, then the same value should be used for both heating and for continuous-circulation. For the heating speed, it is appropriate to use the factory default heating speed provided that this will produce a heating temperature rise that is within the temperature rise range of the furnace. If a case were to be found where this is not accurate, then the heating airflow-control setting should be adjusted to the next higher airflow-control setting until the setting is within the temperature rise range of the furnace.

DOE should abandon the system curve approach in favor of the approach recommend in Section 2 of this letter. This would reduce the burden on manufacturers and would eliminate the need to curve fit and find the intersection of second order polynomials. DOE has not established the field data to support the assertion that the airflow through a duct system can be accurately represented by a single constant. In contrast, DOE requires manufacturers to use three constants to represent the air flow and electrical consumption through a furnace fan.

2. Operating Hour Values for Calculating the Fan Efficiency Rating

The study used to propose constant circulation hours is based on surveys taken in only two states – Wisconsin and Minnesota, where there are high occurrences of indoor air quality issues. Such areas are more likely to use the continuous fan feature. Even in a limited pool within the survey, the "no continuous fan" response constitutes 68% of the surveyed response. A study of constant circulation hours in areas of the country that do not have high occurrences of indoor air quality issues would lead to an allocation that is more representative of behavior in the US and could rightfully be called the US average. DOE should conduct a survey of constant circulation fan use in additional locations in the southern and coastal areas of the US.

Since the current DOE regulations in § 429.12 and § 429.18 of Title 10 require that each manufacturer furnish the input capacity and AFUE of each furnace within DOE's certification report templates, we believe that the heating capacity ratio (HCR) should be redefined as the ratio of input capacity in the lowest heating mode to the input capacity in the highest heating mode.

3. Reference System ESP Values

We believe that the FER should not be based on ESPs in the field since it would encourage poor duct design and a potential for installers to overlook certain aspects of manufacturers' installation instructions. However, in the event that DOE maintains the field ESPs, we ask that the test procedures be amended by adopting our proposed modifications in Section 2 of this letter.

If DOE does not modify this NOPR consistent with our comments in Section 1 of this letter, as far as filters are concerned, we recommend that DOE consider adopting the language in footnote 3 of Table 2 in Appendix M to Subpart B of Part 430 of Title 10 – Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners and Heat Pumps. The footnote states "For ducted units tested without an air filter installed, increase the applicable tabular value by 0.08 inch of water." We believe that adding such a correction factor for filters will alleviate testing burden on the industry since it will help account for the legacy models that were originally tested per the requirements specified in Table 2.

4. Multiple Reference System Method

The two scenarios are meant to represent two installations, but the capacity of the installed furnace and air conditioning system are not affected. The difference between the two scenarios is associated with the adjustments to the furnace fan that are required to operate the furnace and air conditioner safely and to the specifications of the equipment.

By accounting for ESPs that are representative of field conditions in this test procedure, DOE is allowing scenarios that do not comply with the instructions in manufacturers' installation manuals. Such conditions should be discouraged and avoided and manufacturers should not be held liable for improper duct work or improper installation practices. Manufacturers have no control over such conditions. In the poor installation scenario, the installer would be required to select a higher fan speed to overcome the pressure drop in the duct work and establish the proper operating temperatures at the furnace fan. The selection of higher than normally specific fan speeds will result in higher electrical energy consumption for the homeowner, as compared to the design that was tested and rated by the manufacturer.

5. Standby Mode and Off Mode Electrical Energy Consumption for Furnace Fans Used in Hydronic Air Handlers

Per Section 1 of this letter, we believe that hydronic air handlers should be excluded from the scope of this proposed test procedure. The questions on page 28697 of the May 15, 2012 Federal Register notice clearly indicate that hydronic air handlers have previously not been subject to test procedure rulemakings. The very fact that DOE is asking these questions indicates that DOE needs to research these products further.

We are opposed to the concept of the IFER metric since it does not allow for an accurate comparison with products that are associated with the FER metric. In order to avoid consumer confusion in the marketplace, it is essential that the standby and off mode electrical energy consumption be separated from the IFER metric and that FER be used as the sole metric for comparing the furnace fan efficiencies between various products.

6. Controlling ECM Motors for Testing

We agree with DOE that independent test labs will need additional guidance. That guidance may differ depending on the motor and control design. We recommend that the independent test laboratory be allowed to confer with the individual manufacturers for guidance on particular models; however, the performance testing can be made significantly less difficult for independent test laboratories by implementing our suggested modifications in Section 2 of this letter.

7. Test Setup

DOE's assumption that in a typical installation the furnace fan blows through the unit describes a typical non-weatherized gas furnace. The assumption is incorrect when weatherized or electric furnaces are considered. Some fans in weatherized furnaces pull through the entire unit whereas some fans in weatherized furnaces pull air through the evaporator coil section and push air through the gas heat exchanger section. DOE should not disallow any test setups and should provide specific test data and sufficient justification before disallowing any test setups.

8. External Static Pressure

Refer to our comments in Section 3 on the differences between various standards with respect to ESP measurements. In the case of small-duct, high-velocity systems, if DOE does not modify this NOPR consistent with our comments in Section 1, DOE should use the ESPs specified in Appendix M to Subpart B of Part 430 of Title 10.

9. Ambient Pressure Conditions

The current federal test procedure in Appendix M to Subpart B of Part 430 in Title 10 – Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners and Heat Pumps, requires that indoor airflow data be corrected to standard air conditions. For consistency, we suggest that the same requirement be applied to furnace fans.

10. Sampling Plan Procedures and Certification Report Requirements

The proposed test procedure will require manufacturers to invest significant amount of time and resources to determine furnace fan efficiencies in accordance with DOE's current certification requirements. It is disproportionate to the significance of this particular metric and its contribution to the total annual energy consumption of the furnace. As currently proposed in the test procedure, Appendix AA to Subpart B of Part 430 of Title 10 – Uniform Test Method for Measuring the Energy Efficiency of Residential Furnace Fans, section 7.1 requires the following:

- One FER value
- ESP and electrical consumption at each operating point (9 values)

- One Kref value
- Quadratic coefficients for the performance curve for each rated airflow – control setting (9 values)
- Quadratic coefficients for the electrical consumption curve for each rated airflow – control setting (9 values)

Thus, each manufacturer would have to report a total of 29 values in order to meet the requirements of Appendix AA to Subpart B of Part 430 of Title 10. We encourage DOE to adopt our suggested modifications to DOE's proposed FER metric, as discussed in Section 2 of this letter. Not only will the suggested modifications significantly reduce the testing and reporting burden on the industry, the modifications will continue to provide the same qualitative benefits to consumers as the FER metric in the proposed furnace fan test procedure. In order to implement the new requirements on a timely basis while minimizing the burden on furnace manufacturers, the option of employing an alternative efficiency determination method (AEDM) to determine furnace fan efficiency must be made available instead of mandating that a minimum of two samples be tested in order to achieve DOE certification. We do not disagree with the requirements contained in § 429.18 of Title 10 that pertain to the certification testing of AFUE for residential furnaces. However, the requirements in § 429.18 of Title 10 do not apply to the metrics that represent the electrical consumption of furnaces. Although there is value in measuring the performance aspects of a residential furnace fan, the amount of electric energy being measured is significantly smaller, mere percentage points, than the primary energy consumption of the furnace. The testing burden to measure this secondary efficiency metric must be considered with this perspective.

We believe that the proposed 97.5% upper confidence limit of the true mean divided by 1.05 is inappropriate for furnace fans. Based on our initial review of the proposed test procedure and the following reasons, we believe that the upper confidence limit should be 90% of the true mean divided by 1.05:

- Section 4.1.2 of ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 considers a probability of 95% to be acceptable for the standard. Section 6.1.1 of ANSI/AMCA 210-07 I ANSI/ASHRAE 51-07 states that "When performance at only one point of fan operation or performance only over a portion of the characteristic curve is required, the number of determinations shall be sufficient to define the performance range of interest, but at least 3 determinations are required to define a single point off an operation." The DOE procedure does not require multiple determinations per test point. It can be assumed that fewer determinations per test point will increase the uncertainty of the test procedure. This uncertainty applies to the measurement procedure only and does not account to uncertainty due to the manufacturing process.
- The components of the furnace fan are more analogous to an air conditioner than to the combustion process of a fuel-fired furnace. Furnace fan components include electric motors, blower wheels, and blower housings. AFUE does not consider the electrical efficiency of these components.

Lastly, DOE should ensure that the confidence limits with respect to the certification and enforcement of furnace fans are the same and apply to the FER metric only.

Section 5 – Cumulative Regulatory Burden

In a scenario discussed on Page 28692 of the May 15, 2012 Federal Register, DOE estimates that it would cost approximately $2,300 per test for at least two tests to certify the furnace fan efficiency of a new basic model. The added cost of testing, at most, has been estimated to be less than 2 percent of the manufacturer selling price. However, the analysis does not account for the cumulative regulatory burden that will be placed on manufacturers due to the furnace fan efficiency tests. In addition to certifying AFUE of each furnace, manufacturers will be subject to certifying standby and off mode requirements for non-weatherized gas and oil furnaces from May 1, 2013 onwards. 2 percent of the manufacturer selling price is already a significant testing cost for the industry, and accounting for AFUE, standby and off mode further increases the testing and reporting burden even more. Again, we strongly urge DOE to incorporate our proposal in Section 2 of this letter since it will not only alleviate the testing and reporting burden on the industry, but also help meet DOE's overall objectives.

AHRI appreciates the opportunity to provide these comments. If you have any questions regarding this submission, please do not hesitate to contact me.

Sincerely,

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