AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE
we make life better™

2111 Wilson Boulevard Suite 500 Arlington VA 22201-3001 USA
Phone 703 524 8800 | Fax 703 562 1942
www.ahrinet.org

January 6, 2017

Ms. Ashley Armstrong
Office of Energy Efficiency and Renewable Energy
Building Technologies Program
Room EE-5B
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0121

Re: Energy Conservation Standards for Commercial and Industrial Fans and Blowers: Availability of Provisional Analysis Tools – Third Notice of Data Availability *[Docket Number EERE–2013–BT–STD–0006]*

Dear Ms. Armstrong:

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 data availability (NODA) on energy conservation standards for commercial and industrial fans and blowers (CIFB) appearing in the *Federal Register* on November 1, 2016.

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.

COMMENTS

On November 11, 2016, AHRI submitted a request for a public workshop to enhance our members understanding of the Department's proposed changes to the analysis which has changed considerably since the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) Working Group (WG) negotiations concluded. Understanding the details of the changes is important to our ability to properly comment on the rulemaking. Many of the proposed changes directly affect our members and it would have been extremely helpful for the DOE to present the changes to this complex analysis. Further, DOE has published a third version to the Engineering Analysis spreadsheet, without notice to the public, after the initial worksheets (version 2 of the

Engineering Analysis) were posted to the docket on October 19th. It is unclear when version 3 of the Engineering Analysis was published to the docket as the date associated with the document was not revised. It is also unclear what revisions were made between the two versions as no narrative was provided with the new Engineering Analysis. While we appreciate the additional time given to respond to comments, to date, and much to our disappointment, no request for a public meeting has been granted. Such a workshop would still be valuable, and we again request the opportunity to hear DOE present these changes in an open, public meeting.

METRIC

AHRI has concerns with the proposed revisions to the fan electrical input power metric (FEP) and fan electrical index metric (FEI) as recommended by the Rulemaking Federal Advisory Committee (ASRAC) Working Group (WG) to characterize the efficiency levels and represent fan performance. First, AHRI is concerned with DOE's proposal to modify the FEI calculation using a reference value of FEP (FEP_{REF}) of the mid-point efficiency level (EL3) instead of using a value equal to the first energy conservation standards DOE sets (FEP_{STD}). The engineering analysis spreadsheet FEI ≥ 1 indicates that a unit meets or exceeds the level being analyzed which would suggest that fans below EL3 would not meet any proposed standard. It is unclear why the DOE selected EL3 and why was EL0, the baseline level, not selected for this arbitrary reference value.

Secondly, it is unclear from the NODA if it is DOE's intent that this reference value would change over time. If FEP_{REF} were to change during each efficiency change, consumers would not be able to compare fan selections made before and after new standards were implemented. Customers need to be able to compare products as the standards change. The ASRAC WG voted for the FEI to be calculated using the FEP of a fan that exactly meets the standard (FEP_{STD}) which will be fixed in time to the first level established by the regulation. It is unclear from the limited narrative in the NODA why DOE has proposed moving away from the WG's approach. More information needs to be presented regarding this proposal.

SCOPE

AHRI is concerned by DOE's lack of details in the update incorporating additional embedded fans into the analysis. Footnote 11, which ostensibly would provide information regarding additional embedded fans included in the analysis or at least where information could be located, is not present in the NODA. Inclusive in the confusion is the treatment of fan arrays, which are not discussed or addressed. Additionally, the feature that would allow a user to calculate the impact of the rule is not functional in either version 2 or 3 of the Engineering Analysis spreadsheet.

AHRI has continuing concerns with DOE's asserted authority to compose a regulation that imposes additional burden to manufacturers of currently-regulated HVACR equipment. AHRI takes no issue with the fact that DOE has the authority to regulate "fans and blowers" in a stand-alone capacity, but, to avoid overlapping regulations, the

embedded fan exemptions should be broadened to include *all* fans in *all* regulated HVACR equipment. U.S.C. § 6311(2)(A). However, EPCA does not permit two standards to be applied to a single product. ("EPCA authorizes DOE to establish a performance standard or a single design standard. As such, a standard that establishes both a performance standard and a design requirement remains beyond the scope of DOE's legal authority[.]" (74 Fed. Reg. 12,004; 12,009). In addition, DOE has not yet completed and published a legally valid statutorily required determination demonstrating that "fans and blowers" are eligible for regulation as required under 42 U.S.C. § 6311(2)(A). Until such a determination is finalized DOE lacks the formal authority to promulgate any regulations for fans and blowers. DOE is required to follow the mandated procedures set forth in EPCA in order to give all stakeholders sufficient information to participate in the rulemaking process. "All questions of government are ultimately questions of ends and means…Congress has established … the means by which DOE could extend its regulatory authority.'" *Hearth, Patio & Barbecue Assoc. v. Dept. of Energy*, 706 F.3d 499, 507 (D.C. Cir. 2013). DOE must abide by the statutorily-required means and finalize its determination before it can legally regulate any products not currently specified as "covered equipment." AHRI recommends that when DOE finalizes its determination, it excludes from the scope of regulation components of currently regulated covered equipment to avoid the specter of double-regulation, which is contrary to law.

Current DOE regulations for unitary equipment also includes coverage of water source heat pumps used in boiler tower applications. Many HVACR manufacturers serve this market application with a single product that also covers geothermal heat pump applications. While the water source heat pump is covered in the 10 CFR 431, regulation for boiler tower applications, that regulation does not apply to geothermal applications. The fan and blower regulation would mandate that the single product that covers those use applications certify its fans or potentially develop two separate products for different market applications. AHRI urges DOE to exempt water source and geothermal heat pumps entirely due to the industry use of the same products for the different market applications.

Other products and applications present complications and are not a good fit, technically or legally, for fan regulation. Several other products, including commercial water heaters and commercial boilers, are federally regulated but were not excluded during the WG negotiations. This was an oversight that needs to be corrected. The list of exemptions should be amended to include both commercial water heaters and commercial boilers, both of which experience the same burden as furnaces for heat testing redesign, neither of which have been included adequately in the revised analysis. AHRI urges the DOE to contact OEMs of commercial water heaters and commercial boilers to ensure the impact to these products is adequately included in the analysis.

Replacement fans for all equipment manufactured before the effective date of the regulation should be exempted. This is justified because the life of a given product outlasts the life of the fan and it is not practicable to discard a functioning product just because a fan component breaks. If an exact replacement is not allowed by regulation of fans, unsafe substitutions to replace components are inevitable. Offering substitute fans

from the original supplier that have been proven to be *100-percent* (80-percent is not sufficient for safety reasons) equal in fit and function essentially doubles the OEM conversion costs included in the NODA. The NODA fan pricing does not account for the extra amortization of conversion costs or the proprietary nature of the replacement. Buying a custom replacement from a design-build fan manufacturer is not a suitable alternative as these third-party fans are unlikely to be safe or provide sufficient performance because only the original supplier has the knowledge to properly replace the fan in OEM equipment. If gas or electric heat is present, or seismic certification is required, then this option is not safe without extensive testing. The NODA fan pricing does not account for the extra amortization of conversion costs or the proprietary nature of the replacement.

It is evident that neither the cost nor the time to replace fans in OEM equipment or the OEM equipment itself is included in the analysis. It could take months to replace commercial equipment with embedded fans. If the DOE insists on keeping replacement fans in scope, it needs to include down time for businesses, temporary air conditioning or heating or water heating, as well as other business costs in the analysis. Subjecting all replacement fans to regulation will likely have a negative impact on energy efficiency as building owners will be driving to replace HVACR equipment on an emergency basis, and not as part of a planned building improvement. When consumers are forced to make large expenditures on an emergency basis, they are unable to take advantage of higher efficiency, more expensive equipment. Most replacement fan parts are sold by the parts department of HVACR OEMs; and are generally not sold in a “testable configuration,” therefore the exemption of replacement fans and replacement fan parts will not likely create enforcement issues or loopholes.

AHRI also recommends excluding condenser fans in commercial and industrial chillers, condensing units, and unregulated packaged air conditioners and heat pumps with cooling capacity greater than 760,000 Btu/h from the scope of the regulation because regulating these fans, or most other components in HVAC equipment, does not save energy. The market determines the desired efficiency of the chiller, condensing unit, air conditioner or heat pump. *System level* minimum system level efficiency (IEER and EER) are prescribed by ASHRAE Standard 90.1 or a local/state code. The use of a system level efficiency metric is favorable compared to regulating individual components as systems can be optimized to take advantage of component to component interactions. A result of a regulation that increases condenser fan efficiency is that manufacturers will try to reduce cost in other components, like coils, to remain competitive in the marketplace while providing the required unit efficiency. For example, manufacturers have stated that reducing the condenser coil fin density would be done simultaneously with a change in the condenser fan. It is our hope that the Department understands and agrees with the above concepts because most other heat rejection fans have already been excluded from the scope of the CIFB regulation. If DOE does not exclude these fans, then the NODA energy savings must be adjusted accordingly.

ANALYSIS ISSUES

AHRI has fundamental concerns with DOE's analysis using a database of fans with efficiencies established at a variety of different speeds. This is significantly different than the agreement made at the work group for establishing product performance and also different from subsequent proposals made to the Department by other commenters to this rulemaking. Also, as disclosed during ASRAC negotiations, much of the data in the database was not certified performance and may not be reliable for evaluating the impact of efficiency standards.

As noted previously, the Engineering Analysis was republished (v3) without notification or comment to the public about what changes have been made after version 2 was posted to the docket on October 19th with the other worksheets. The Department cannot expect the public to be able to effectively comment if they are working with outdated material.

DOE has stated that they have adjusted the number of Forward Curved (FC) and embedded fans in the analysis, but have not provided any details on the additions. AHRI contends that based on our assessment, which is incomplete due to lack of information in the NODA, the number of embedded fans included in the analysis is likely inaccurately and does not completely capture the market.

The Engineering Analysis has no way to analyze the impact of the proposed regulation on fan arrays. Version 3 spreadsheet instructions state that it is possible to enter the number of fans for a fan array, but that column does not appear in the spreadsheet. The definition of fan appears to suggest that person or entity who packages drives with a fan is a fan manufacturer; however, this does not appear to be consistent with the term sheet. DOE needs to clarify that a certified fan bought from a manufacturer for inclusion in OEM equipment will not need to be re-certified to DOE by the OEM if a VFD and/or drive is added. The text in question, from the Engineering Analysis (v3) and is underlined, below:

> Fan - a rotary bladed machine used to convert power to air power, with an energy output limited to 25 kJ/kg of air, consisting of an impeller, a shaft, bearings, and a structure or housing; and <u>includes any transmissions, driver, and control, if integrated, assembled, or packaged by the manufacturer</u> at the time of sale.

The proposed definition for "housing" is also concerning with regard to fan arrays. If the housing is, "any component(s) of the fan that direct(s) airflow into or away from the impeller and that is the first layer enveloping the airflow, starting from the impeller." And, "a housing may serve as a fan's structure," then it is unclear how walls between fans in an array should be treated. If an OEM puts wall between fans in an array and that wall is the first object that the air hits after leaving the impeller, is that wall now part of the housing? Is any centrifugal unhoused fan in an array considered a housed fan because of the walls between fans? Also, centrifugal unhoused fans do have devices that that direct airflow into the impeller. Does this feature actually qualify them to be

considered housed fans? The DOE needs to provide adequate clarification regarding scope issues.

Several incorrect assumptions have been noted in the analyses regarding embedded fans. It is not reasonable to assume that substitutions can be made for any fan within 20-percent of static pressure/airflow of requirements and within two inches of the original diameter tolerances. Selecting a fan that is within two inches of diameter would translate to a four-inch increase on housing size. Commercial HVAC equipment fan selection requires design to a specific airflow and static pressure. Many times a two-percent selection window is required. Indeed, variable air volume systems and systems with economizers need to operate over a range of airflow. Low static, high airflow fans (FC) fans are used in these applications. If DOE insists on maintaining the original assumptions, it needs to account for the fact that the number of fans requiring redesign is closer to 100-percent than the 30-percent included in the current analysis.

The data used in DOE's analysis per their reporting is from the AMCA database which uses legacy data (selections not tested at the mid-range or average speed) which are not necessarily certified. As this data are not per the WG agreed-upon test conditions, it brings into question the validity of DOE analysis. This is an issue because it is well known that fan efficiency changes with test speed. Efficiency changes with test speed result in a variation of the compliance bubbles for the different EL's. The second part of the concern with using legacy data is that all fan data is published as "typical" where fan manufacturers target nominal execution of designs and hopefully nominal measurements. In other words, uncertainty of measurement and manufacturing are not accounted for. Under that scenario, half of the products could fail to comply with a minimum standard. AMCA 210 gives clear guidance on measurement uncertainty while manufacturing tolerance will be a manufacturer specific variable.

The timing of finalizing a test procedure and standard levels is pivotal, particular in this case where the test procedure at issue is still in draft form. AHRI requests that DOE finalize its test procedure for any CIFB rulemaking before a NOPR introducing standards is published so that stakeholders have an opportunity to comment on the effect of the test procedure for the purposes of the standards rulemaking. Any other process is contrary to the legal requirements of EPCA. Also, AHRI urges DOE reanalyze fan efficiencies and reissue the analysis using test data that reflects the WG's agreed upon test method.

It is counterintuitive that the life cycle cost curve is flat even though costs change as efficiency levels increase. The Department needs to address this inconsistency.

FORWARD CURVE FANS

As we have stated many times, forward curve centrifugal housed (FC) fans warrant a separate equipment class. It is unclear what the Department has done to improve the analysis regarding FC fans. Forward curved centrifugal housed fans require a separate equipment class for compact sizes compared to backward curved fans providing the same airflow and pressure and they provide *code-required* sound quality in low pressure

and speed ranges. AHRI is concerned that DOE has denied these legitimate performance-related features that justify differing standards for FC fans by citing a single FC fan meeting EL5 in a database of over 1.3 million fans of unreliable and/or questionable fan performance data. As previously discussed in these comments, the speed at which that fan was tested is not known, as there are no current requirements to test speed when complying with current industry test procedures and no DOE procedure has been finalized so there is no way to be sure what EL that fan would actually meet. Further, the application ranges of FC fans by customers for low footprint, low static pressure and high airflows is very broad. As airflows and/or static pressure needs are increased there are few to no FC fans at higher ELs currently available in the market.

DOE did not respond to industry concerns regarding the necessity to preserve sound quality as a performance-related features that justify differing standards. This issue must be addressed.

AHRI requests that the DOE repopulate the fans database with comparable performance levels after a test procedure has been finalized, and reconsider a separate equipment class for forward curve centrifugal housed (FC) fans.

There is also concern that the Department has not properly accounted for the cost of forward curve fans in the analysis despite the first round of interviews with OEMs. No significant cost difference can be discerned between EL0 and EL6 which is absurd considering the significant impact of increasing the fan housing even by one inch. Also, it is evident that OEMs will have to offer more fan models per product to span the same airflow range where just one suffices now as efficiency levels increase and compliance bubbles shrink. As stock increases, shipping and other manufacturing costs are expected to rise. It is imperative that the Department engage in additional OEM interviews and appropriately use the information it receives to improve this analysis.

COMPLIANCE YEAR

AHRI disagrees with DOE's belief that fan manufacturers will be able to offer fans that are compliant with any energy conservation standards DOE may set before 5 years after publication of a final rule to the extent required to fully analyze and potentially redesign millions of individual models over the entire size range offered on the market today.

If the CIFB regulation affects the market availability of currently used fans in unregulated product applications, OEMs will be forced to buy and use different fans. This shift in a vital component will require redesign time and revalidation time for products that use those products. AHRI requests that to the extent that the CIFB regulation will affect the availability of fans on the market for HVACR OEMs, that a phase-in of the regulation is adopted. Once the regulation takes effect over fan suppliers, component fans that were once available, may no longer be, but OEMs will not have the information about market availability until well after the regulation has gone into effect. After assessing the availability on the market, OEMs may have to redesign equipment to accommodate for a

different fan type or fan size. This redesign takes years and the information requires for this equipment assessment will not be available until after fan manufacturers are actually complying with the rule. Addition conversion costs are often required after the fan and cabinet have been redesigned and this also takes years to complete. Seismic and wind load testing have not been accounted for in time or cost in the analysis. This testing must take place upon internal component swaps or cabinet redesigns and is required before products can be sold. Also, testing must be conducted for furnaces, electric heat, safety, refrigerant, and sound when components or cabinets are redesigned. DOE has assumed that the equipment cabinet size would not change if the fan changes diameter by two-inches, and this is simply not correct. No information supporting this supposition has been made available to the public and all comments by manufacturers has been to the contrary. The size of cabinet would change with an increase in fan diameter of two-inches and all retesting noted above would be required. The $150,000 per fan conversion cost assumed by DOE are understated and a more realistic cost estimate of activities to achieve compliance for one model of equipment is below:

	Activity	**Cost**
1	Evaluate, through analysis and testing, whether current exhaust blowers comply. (Assume non-compliance for this estimate)	$24,000
2	Select higher performance fans that meet the application needs for the product	$50,000
3	Design and build prototypes. Test for operation.	$60,000
4	Repeat for models that do not comply.	$30,000
5	Design wiring, markings, labels to complete product design details	$40,000
6	Safety agency approvals	$10,000
7	Packaging design and development, testing, final assembly drawings	$40,000
8	Manufacturing fixturing, routing and costing activities	$20,000
9	Development and publication of technical literature	$10,000
10	Product, aftermarket and launch activities	$20,000
	Total Cost Estimate	$304,000

Even if cabinet does not change size, much of the same testing would still be required. Therefore, OEMs request that the regulation is phased-in to allow for redesign time of existing products that will be affected by the shift of fans available on the market. AHRI requests that OEMS are not required to exclusively use certified fans in unregulated equipment until five years after fan manufacturers begin certifying their fans.

ISSUES ON WHICH DOE SEEKS COMMENTS

AHRI appreciates the opportunity to comment on issues in which the DOE has expressed interest.

1. DOE requests feedback on the calculation of the FEP_{STD} and FEI.

   AHRI Response: DOE did not provide any details as to why it has proposed using the mid-point efficiency level (EL3) as a reference value (FEP_{REF}) for the standard, as opposed to a value equal to the first energy conservation standard DOE may set (FEP_{STD}) which was the WG recommendation (#6) in the final term sheet. Also, no details have been provided as to DOE's intent for future rulemakings regarding this proposal. Will the next standard have a different reference value? If so, FEI's between different standards would not be comparable. It is imperative that customers are able to compare products manufactured before and after subsequent efficiency standards are set. Another important feature for a metric is to be able to compare one product class to another based on efficiency at a particular design point. It is not clear if DOE's proposal will achieve this aim.

   Several other stakeholders are proposing additional modifications to the metric; however, AHRI has not had sufficient time to review these proposals to determine if there is support, or any concerns. There would be much benefit to having the opportunity to discuss the reasoning behind and impact of both DOE and stakeholder proposals to modify the metric.

   AHRI supports a public workshop to review proposed changes to the metric.

2. DOE seeks comments on the equipment classes used in this notice.

   AHRI Response: AHRI cannot stress enough the importance of maintaining a separate class for forward curve centrifugal housed (FC) fans. This component is the bedrock of HVACR air movement and vitally significant to millions of products sold each year, and tens of millions of products in the installed base. FC fans are compact compared to backward curved fans providing the same airflow and pressure and they provide *code-required* sound quality in low pressure and speed ranges. DOE must reconsider the utility forward curve centrifugal housed fans provide and reevaluate establishing a separate equipment class.

3. DOE seeks information on whether there are specific sizes or operating points where forward curved fans would no longer be available at efficiency levels up to EL 5.

   AHRI Response: It is not clear if or how many FC fan selections have been added to the database since WG negotiations concluded last year, so we are unable to analyze specific sizes or operating points which would no longer be available at efficiency levels up to EL5. As was stated above, it is not appropriate to use the

data in the database as the efficiency cannot accurately be evaluated at unknown test speeds. There is general consensus in industry that without a separate product class, forward curved fans may fade from the market and their lack of availability will negatively impact the cost and use in many legitimate applications.

DOE has cited a single example of a small FC fan which meets EL5, but it is not clear if this observation was made after bolstering the database with FC fans manufactured by OEMs. During negotiations, AHRI presented data collected from members: That approximately 82-percent of fans in all commercial equipment (over 125 W) are manufactured by the OEM. If significant additional selections were not collected, the database still would not accurately describe the FC fan market. It is DOE's responsibility to show, in detail, that FC fans, in all sizes, are commercially available for low static pressure and large airflow rates at any efficiency level considered.

4. DOE seeks comments on the use a compliance date of five years after the publication of the final rule.

AHRI Response: Timing remains an important consideration for this rulemaking. If the CIFB regulation affects the market availability of currently used fans in unregulated product applications, OEMs will be forced to buy and use different fans. This shift in a vital component will require redesign time and revalidation time for products that use those products. AHRI requests that to the extent that the CIFB regulation will affect the availability of fans on the market for HVACR OEMs, that a phase-in of the regulation is adopted. Once the regulation takes effect over fan suppliers, component fans that were once available, may no longer be, but OEMs will not have the information about market availability until well after the regulation has gone into effect. Additionally, many manufacturers have noted that the reduction of operating range will require additional fan sizes to be available in each cabinet to provide the same utility as is available today. After assessing the availability on the market, OEMs may have to redesign equipment to accommodate for a different fan type or fan size. This redesign takes years and the information required for this equipment assessment will not be available until after fan manufacturers are actually complying with the rule. Therefore, OEMs request that the regulation is phased-in to allow for redesign time of existing products that will be affected by the shift of fans available on the market.

Again, AHRI requests that OEMS are not required to exclusively use certified fans in unregulated equipment until five years after fan manufacturers begin certifying their fans.

5. DOE requests information on the per-model (i.e., a single size fan within a fan series) redesign costs presented in the engineering analysis and conversion cost spreadsheet.

   AHRI Response: DOE's fan redesign costs presented assumes that the conversion cost to redesign a fan is near constant irrespective of efficiency level. This incorrectly indicates that increasing fan efficiency for given fan classes is easy to achieve. It is a poor assumption that current fans that may have larger operating maps with greater turndown ratios may be redesigned to EL1 or EL6 at near equivalent costs. As fan efficiency levels are raised, the need for new technologies to hit all operating map conditions is necessary and difficult to assess the impact of implementation. Engineering work, test validation and test verification is required to reach those efficiency levels.

   The difference in cost between EL levels in the "Summary by EC" tab in the LCC spreadsheet is terribly understated. We have assumed that the EL0 housed centrifugal installed cost of $2,265 presumably represents an FC fan while an EL4 installed cost of $2,431 likely represents a backward incline or airfoil fan. This vastly understates the difference in cost between FC and backward incline or airfoil fans. Furthermore, embedded backward curve fans have flatter performance curves and do not develop as much pressure when dampers close so they do not require special controls. Backward curve fans are not self-limiting with respect to speed and require a switch to limit pressure. These pressure switches usually cost in the $20 to $30 range and should also be included in the installed cost, especially on light commercial applications with low pressure ducts, non-metallic ducts and flex duct.

   There is also concern in the installed panel fan cost between EL4 and EL6. AHRI members supplied data to DOE's contractors indicating the cost difference between these two efficiency levels is significantly more than $92.

   Lastly, it is unclear where conversion cost amortization calculated in the LCC. AHRI requests that DOE make clear where these costs are accounted for in the analysis.

6. DOE requests information on the number of models that are currently in the scope of the rulemaking nationally.

   AHRI Response: During the ASRAC WG negotiations, AHRI collected the number of fans that members manufacture versus purchase for equipment with fans 1 hp and above in 2014. From this survey, we estimated the number of models of fans in OEM equipment impacted by this proposed rule to be between five and 14 million.

7. DOE requests feedback on the quantity of redesigns, methodology, and results used to calculate the total industry conversion costs by equipment class and EL, as presented in the engineering analysis and conversion cost spreadsheet.

   AHRI Response: DOE made assumptions in its OEM Equipment Conversion Costs that each redesign would cost $150,000 irrespective of increase in efficiency level requirements. While this assumption may be valid on the basis that the newly design fan fits within the same footprint of previous fan, it underestimates the OEM equipment conversion costs if the new fan is of larger diameter and/or footprint. As indicated previously, the DOE assumptions that a two-inch fan diameter increase equates to the same OEM equipment package is not a valid assumption nor is the assumption that ±20-percent airflow/static pressure is equivalent to equipment customers. A fan with any equipment change would constitute a major product redesign and would see much larger costs that $150,000 per model. AHRI is concerned that DOE's use of this low figure disregards the feedback given by HVAC manufacturers to Navigant and incorrectly presumes that fans are available at equivalent footprint for all applications, airflows and static pressures.

   There will not be one-for-one fan substitutions, especially as efficiency increases in OEM equipment. Manufactures will need to offer multiple fan options in the same cabinet to cover range currently covered by single fan. More OEM equipment models translates to more customized designs, increased tooling costs and tighter tolerances with higher efficiency products. All these factors lead to significantly higher manufacturer production costs.

8. DOE requests information on the extent to which product conversion costs and/or capital conversion costs are shared among sizes in a fan series.

   AHRI Response: No comment.

9. DOE requests information on the extent to which product conversion costs and/or capital conversion costs are shared between belt and direct drive fans with the same aerodynamic design.

   AHRI Response: No comment.

10. DOE requests information on the extent to which product conversion costs and/or capital conversion costs are shared between fans of different construction classes of the same aerodynamic design.

    AHRI Response: No comment.

11. DOE requests information on the portion of equipment with embedded fans that would require heat testing for certification with any new energy conservation standards.

    AHRI Response: Based on information collected from AHRI members, approximately 60% of HVAC equipment sold have fans with heating functions which would require heat testing. One hundred-percent of commercial boilers and commercial water heaters have fans with combustion functions which would require retesting. Products included in the calculations are highlighted in red, below:

    - Automatic Commercial Ice Makers
    - Commercial AC/HP (ULE)
    - Commercial Boilers
    - Commercial Refrigeration Equipment
    - Commercial Water Heaters
    - Datacom Cooling Units
    - Direct Heating Equipment
    - Furnaces
    - Packaged Terminal AC/HP
    - Single Package Vertical Unit
    - Unit Heaters
    - Variable Refrigerant Flow
    - Walk-in Coolers and Freezers
    - Water Source HP
    - Active Chilled Beams
    - Air Cooled Chillers
    - Air Cooled Condensing Units
    - Air-to-Air Energy Recovery Ventilators
    - Central Station Air Handling Units (Commercial and Custom)
    - Cooling Tower/Evaporative Condenser
    - Dedicated Outdoor Air Systems
    - Direct Heating Equipment
    - Mobile Refrigeration Equipment
    - Room Fan Coil Units
    - Unit Ventilators
    - VAV Units (Including Series Fan-Powered Cooling Terminals)

12. DOE requests feedback on the number of embedded fans that would require redesign presented in the engineering analysis and conversion costs spreadsheet.

    AHRI Response: OEM Equipment Conversion Costs do not appear to include the cost of the equipment redesign and retesting; therefore, the costs are underestimated. The cost also does not appear to be inclusive of all fans needing redesign. The DOE fan-substitution assumptions in the Engineering Analysis that

the replacement sale had to meet the following requirements: in the same fan class, no more than two inches larger than the sale being replaced, and within ±20-percent on selection airflow and total pressure (for ducted fans) or static pressure (for unducted fans) would likely require near 100-percent redesign of equipment with embedded fans. Limiting the range of operation of fans will also have a significant negative impact for the redesign of combustion systems. It is expected that this limitation will force the redesign of every combustion appliance using that fan and will likely increase the energy consumption of combustion appliances by reducing turndown rates and increasing off cycle losses. For OEM equipment, any substitution requires testing. Testing includes seismic and wind load testing, neither of which have been accounted for in time or cost. Approximately sixty-percent of the fans in OEM equipment provide heating and those require significant safety testing. Fans providing cooling require refrigerant testing. Any unit that would be specified for schools require sound testing. This is all in addition to testing for efficiency ratings and recertification of equipment.

AHRI members will incur significant additional cost to develop models that require seismic certification. Seismic certification requires expensive shake tests of complete units and can only be maintained through a fan change if the new fan is not heavier and utilizes identical structural support. A typical program would involve testing two units of a given model series. Costs include the unit cost, cost of modifying the unit to meet the seismic load, seismic consultant fees, and test center fees. Our members' estimate, typical large commercial unitary equipment (>63 tons) will cost more than $300,000 for each model series tested for seismic certification.

Further, it is unclear from this NODA the overall impact of the inclusion of any OEM Equipment Conversion Costs on the analysis. AHRI urges DOE to properly and completely account for the cost of both the required redesign of fans within the equipment; the addition of multiple fan offerings to cover the airflow range a single fan used to cover; and the full cost of redesigning and retesting the equipment to accept. Changes to the analysis should be articulated clearly to the public in narrative form and not hidden in tabs on individual spreadsheets. This obfuscation makes it difficult for commenters to provide valuable, specific, feedback.

The bottom line is that any change in fan type or diameter will likely require a complete redesign and retesting of the equipment in which that fan is embedded. This change is so significant that the piece of equipment would need to be treated at new. Any change to airflow will require extensive retesting. DOE's fan-substitution assumptions in the Engineering Analysis are not valid for embedded fans.

13. DOE seeks feedback and input on the 2012 standalone fan and embedded fan shipments values, by equipment class and subcategory. Specifically, DOE requests feedback on: (1) the estimated number of fans per HVACR equipment; (2) the distribution of HVACR fans across fan subcategory by fan application; and

(3) the share of standalone fans purchased and incorporated in HVACR equipment.

AHRI Response: At the July 22, 2015 ASRAC WG meeting, AHRI presented data compiled from a survey of its member to determine ratio of fans purchased to fans manufactured in-house on regulated commercial equipment. Respondents were asked to provide the number of fans included in equipment which would fall under the scope of this regulation and what percentage of those fans were manufactured in-house. The definition provided for a "manufactured fan" is one where the impeller is purchased or manufactured and the fan is assembled by the OEM. Data was presented for the commercial AC/HP (Unitary Large Equipment), which got the best response at 88-percent of the market responding. Data showed that between 94 and 99-percent of all fans in commercial AC/HPs are manufactured by the OEM. The table, below, also presented at the July 22, 2015 meeting, has been reproduced:

% of Connected Load		
	Purchased	Manufactured
Evaporator Fans	0.63%	99.37%
Condenser Fans	2.37%	97.63%
Total	1.09%	98.91%

While the commercial AC/HP was verified to be the most complete data set, all commercial regulated equipment (over 125 W) was analyzed, and it was determined that approximately 82% of fans in all are manufactured by the OEM. This trend holds for unregulated commercial products as well.

It is difficult to provide an estimate for the number of fans per HVACR equipment as this rule impacts virtually the entire product line for more than 24 different HVACR products. Air-conditioning equipment will have at least two fans, but the largest, unregulated, commercial AC/HPs can have 10 or 11 fans in each unit. Based on data analyzed, we found that there were approximately three fans per commercial AC/HP unit sold in 2014. With condenser and supply fans exempted, this still leaves at least one-third of the fans within the scope of the rulemaking. Commercial and custom central station air handling units will have a supply and exhaust fan at minimum, sometimes a return fan or an array of fans for supply. It would be reasonable to estimate three fans per unit based on the commercial AC/HP data. All of the commercial and custom central station air handling units' fans are within the scope of this rulemaking. Overall, we estimate the impact to be five to 14 million fans in HVACR equipment.

14. DOE seeks feedback and input on the distribution of fan selections by power bin and subcategory for standalone fans and embedded fans as presented in the "LCC sample Description" worksheet of the LCC spreadsheet.

    AHRI Response: The distribution of fan selections by power bin and subcategory for FC fans within centrifugal housed fans does not take into account the low static and high airflow conditions in which these fans are applied. Grouping airfoil, backward curve and FC fans together in power bins and efficiency levels does not allow for independent analysis of their significantly different applications in commercial buildings. In order to justify the inclusion of FC fans in with all other centrifugal housed embedded fans, DOE needs to indicate the airflow and static pressure distribution to better show the application of these fans.

15. DOE seeks feedback and inputs on the fan operating hours.

    AHRI Response: Fan operating hours is highly dependent on the type of building (hospital, office building, school, retail, etc.) and the type of equipment. It has been noted that the operating hours for stand-alone fans has not changed. AHRI cannot determine why this is the case. Many stand-alone fans are installed in commercial buildings and their hours should be adjusted accordingly.

16. DOE seeks feedback and inputs on the fan load profiles used in the energy use calculation and on the percentage of fans used in variable load applications.

    AHRI Response: Based on a review the "Sectors and Applications" tab in the LCC workbook, the logic behind the two load profiles is unclear, one for 60-percent of fan selections in the Commercial Sector. If the two load profiles represent "modulating VFD" and "two speed" control options, it would seem that the relative volumes are reversed. VFDs are primarily used on in-scope products and AHRI recommends increasing the 25-percentage of design flow bin to account for 15 to 20-percent of the annual operating hours and the 75- percentage of design flow bin should be reduced accordingly. If the two load profiles do not represent "modulating VFD" and "two speed" control options, AHRI requests that DOE clarify the fan load profile intent.

17. DOE seeks feedback and inputs on the fan lifetimes

    AHRI Response: AHRI suggests that 17-years is appropriate for equipment lifetime for indoor products, but 15-years is more appropriate for outdoor equipment.

Conclusion

AHRI appreciates the opportunity to provide these comments. As noted, we have significant concerns regarding the metric, scope, equipment classes, implementation and, most fundamentally, with the analysis. The analysis and ultimate proposal of efficiency

levels should not be based on a database of fans with efficiencies established at a variety of different and unknown speeds. While deviations from agreements made during ASRAC negotiation may be warranted for developing a complex rule, these proposals need to be presented clearly and discussed by stakeholders. We reiterate our request that DOE present the changes to the analysis through an open, public meeting and provide an opportunity for stakeholders to ask question and achieve some clarity. If you have any questions regarding this submission, please do not hesitate to contact me.

Sincerely,

Laura Petrillo-Groh, PE
Senior Engineering Manager, Regulatory Affairs
Direct: (703) 600-0335
Email: LPetrillo-Groh@ahrinet.org