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On Notice of Data Availability for Commercial and Industrial Fans and Blowers

Additional submitted attachment is included below.

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January 6, 2017

Re: Morrison Products Comments on Department of Energy's (DOE) Notice of Data Availability (NODA) for Energy Conservation Standards for Commercial and Industrial Fans and Blowers [Docket Number EERE-2013-BT-STD-0006]

Dear Ms. Armstrong,

Morrison Products, Inc. is a manufacturer of air moving products supplying blowers and fan products to manufacturers of air-conditioning and heating equipment. Morrison supplies fans to 200+ companies producing residential and commercial air conditioning equipment that is manufactured and sold in North America. We have three U.S. manufacturing facilities, regionally located with over 300 employees and one Mexican facility supplying Mexican, Central and South American customers with 40 employees.

The following comments are presented as response to the U.S. Department of Energy's (DOE) notice of data availability (NODA) regarding energy conservation standards for Commercial and Industrial Fans and Blowers appearing in the Federal Register on November 1, 2016.

I. ASRAC Working Group Recommendation #4

Recommendation #4 of the Term Sheet was left unresolved and we would like to make this observation. Morrison believes that the greatest energy use reduction, in conjunction with the best economic point, is accomplished at the system level. Component level regulation unnecessarily constrains system designers in ways that may not lead to overall system energy reduction, especially at a cost in which the market can support (necessary for the widest adoption). Applied Fans and blowers are different than motors and pumps as they are usually an integrated part of the larger system. The fan/blower device is often built into the overall system and the interface between the two is more complex as parts of the system affect fan performance and vice versa. Measuring system level performance relative to fan level performance is complicated in appliances and ensuring fan compliance would require a test procedure for the appliance to ensure fan performance is acceptable. And logically, if there is an appliance test standard, then it would be best to have an efficiency standard for the appliance.

II. General Comments

1. The basis for the engineering analysis in this NODA along with all the previous work at DOE and its consultants is based on the extensive database of fans submitted by AMCA. This database has performance values for both air and power that come from AMCA and member testing based on AMCA 210. AMCA has requested that their members be allowed to use legacy data and not retest at the mid-range or average speed along with using their legacy data for fan selection (Letters to DOE docket EERE-2013-BT-STD-0006 published October 18, 2016 and January 26, 2016).

   The issues listed below affect all areas of the NODA analysis (EA, LCC, NIA, and GRIM) and they should be looked at cumulatively, as they are additive, and not individually through a series of singular sensitivity analyses.

   a) The request by AMCA to use legacy data illustrates that the AMCA data is not per the ASRAC Working Group (WG) agreed upon test conditions and brings into question the validity of DOE analysis that uses this data as a starting point. In the WG term sheet, Recommendation #17 has a defined speed of test as being essentially the average speed between the maximum rated and minimum speed for a given fan. AMCA 210 does not give guidance on speed of test (other than intended operating point for specific design fans) and tests of fans are often done at a variety of speeds for various reasons that may not coincide with the average speed. While the so-called "fan laws" allow minor adjustments in speed to estimate other performance points, they do not account for changes in efficiency that occurs in fans as speed changes (see Figure 1 below). This change in efficiency is seen in all rotating fluid machinery and can be fundamentally described. As the base data used in the DOE analysis comes from unknown test speeds and the compliance bubbles for fans will change with the speed of test, the change in test speed will have varying effect on the operation map and level of compliance. An example for a fan can be seen below in Figure 2. It shows the performance map for a well-designed FC blower with good efficiency. Efficiency changes with test speed result in a variation of the compliance bubbles for the different EL's.

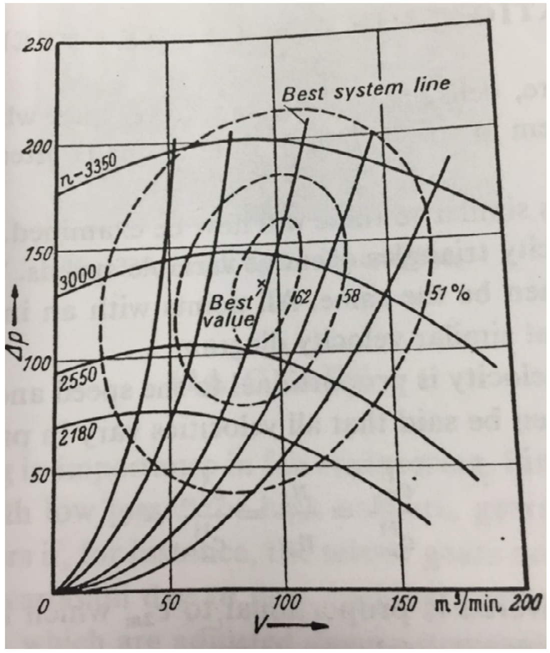

Figure 1 – Fan Curves at Various Speeds Showing Efficiency Change

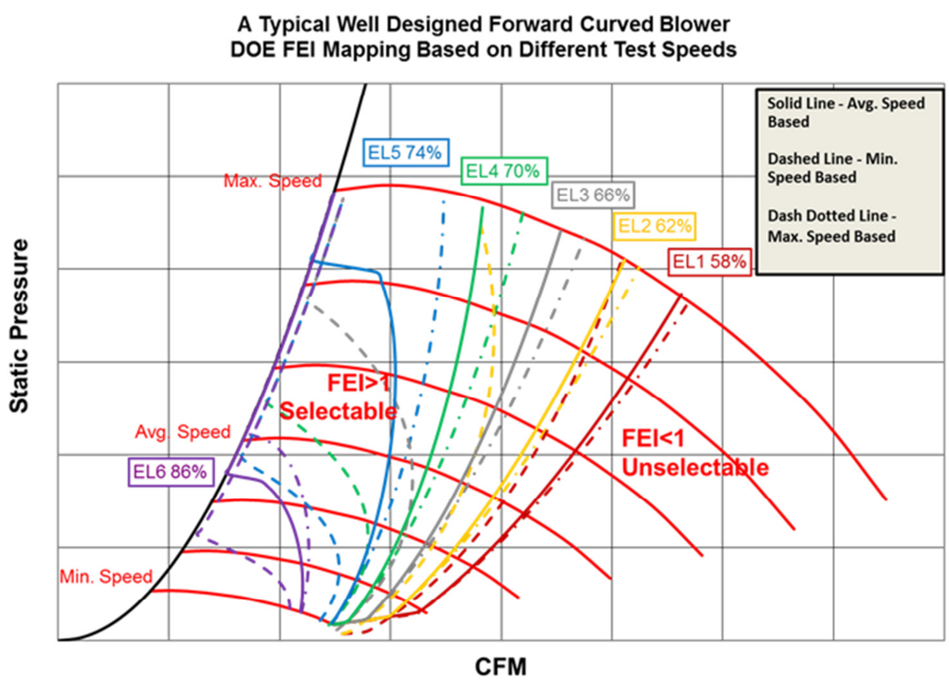

Figure 2 – Fan Map for Various Speeds of Test and Effect on Compliance

b) The second part of concern with using legacy data is that all fan data is published as "typical" where fan manufacturers target nominal execution of designs and hopefully achieve nominal test measurements. In other words, uncertainty of measurement and manufacturing are not accounted for in the legacy data. Under a scenario where that data is used for analysis and certification, half of the products being reported as exceeding any given EL would fail and not be in compliance with a minimum standard – in DOE's analysis where compliance is claimed, statistically half of all fans in this analysis would fail a compliance test. AMCA 210 gives clear guidance on measurement uncertainty while manufacturing tolerance will be a manufacturer specific variable that is affected by many factors including fan, housing, bearings, drive components, controls and motors.

c) Trane and others have pointed out that the 20% airflow selection tolerance is not reasonable. We agree that the change in selection window is significant and would not at all result in an equal fan selection. Under most circumstances a 2% selection window is the best allowed and often there is a 0% under and a 2% over requirement.

d) Selecting a fan that is within 2" on diameter would translate into about 4" on housing size change. Note to get better efficiency, the fan size will always be larger. An extra 4" is rarely available in any application (major unit redesign and installation problems), so the selection again is not equivalent.

For the above reasons, DOE needs to start the NODA over and begin with test data that reflects the WG's agreed upon test method. When adjusting the curve for the other factors stated above, the Department will find the claim of reaching EL5 is not always readily achievable when all factors are accounted for and maybe virtually impossible in many cases.

2. Without a defined test procedure, it is problematic to fully evaluate and comment on this NODA. Further, there are conflicting comments from various groups regarding the correct process to follow for this effort. AMCA, Greenheck and others have argued for the use of AMCA 207 (draft form) and other calculation modifications including the use of FEI verses FEP along with formula simplification. While we are not inherently opposed to any of these suggestions and may actually be in support of the changes, we see that there is a great deal of work to be done to ensure the correct process is followed and unforeseen problems are not realized as a result of a hasty rush to finalize this important regulation. Further evaluation of the options is suggested and a public review meeting to discuss the relevant effect this will have on the fans and equipment manufacturers as well as the buying public. Moreover, there are discussions ongoing in the EU with their proposed 2020 update to Commission Regulation No. 327 where the proposed levels are not technically feasible and we would not wish to see those duplicated here.

3. Given the ongoing regulatory activity of HVAC products in many areas (among them: package units, new refrigerants, air conditioning, furnace, furnace fans as well as ASHRAE standards and local items like CEC regulations in California) there will be constrained engineering departments, test facilities, certification labs/personnel as well as limited time that will make it very difficult to layer on top of them potential fan redesigns. The fan and HVAC industries ability to respond to these timing difficulties will present a substantial hurdle and these layered costs are not accounted for in this analysis.

4. We are of the belief that significant changes are necessary to the evaluation of fan performance, efficiency and cost and assessment methods in order to ensure that the original intent of the Energy Policy and Conservation Act is fulfilled, that the testing burden imposed on manufacturers is minimal and maximum benefit is realized. The following specific comments are from our review of the NODA:

III. Issues on Which DOE Seeks Comments

We offer the following comments on the issues DOE listed in the NODA:

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

MORRISON Response: This proposed change along with the proposed changes from AMCA, Greenheck and others to the calculation of FEI/FEP is still under evaluation and while the 30 day extension was somewhat helpful, an additional 60 days to evaluate this late change to the ASRAC Working Group Term Sheet (as requested by other interested parties) along with a public review meeting and clear explanation for the new spread sheet (3rd version of the Engineering Analysis) that mysteriously appeared after the publication of the original NODA on October 20th, would help our analysis. Specifically, the variety of comments and concerns raised highlight the unfinished nature of this proposed regulation and the uncertainty around its real effect on OEM's and the buying public. At a minimum, in addition to the additional time, there is a need for an open meeting where these changes can be explained and discussed transparently.

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

MORRISON Response: Housed (Centrifugal) - Morrison believes separate equipment classes for Housed (Centrifugal BI/AF) and Housed (Centrifugal FC) is necessary. With separation into two classes, energy savings for all fans can be realized by establishing separate efficiency levels for the two classes. Grouping Centrifugal AF, BI and FC fans together will minimize the potential for energy savings with AF and BI fans while placing a larger burden of savings on FC fans. The following items specific to FC fans needs to be considered:

- Forward curved fans are typically applied as embedded fans in HVAC equipment that require many additional considerations versus standalone fans. A few of these include: (1) lower fan sound requirements in proximity to occupied spaces, (2) wide operating ranges, (3) safe integration with electrical and gas fired furnaces, (4) additional MPC costs outside of the fan alone conversion costs and (5) special design considerations for variable airflow resistance systems.
- FC fans have a unique utility in their compact size and low sound levels. Low sound levels are vital to classroom learning and are part of codes and standards. This is especially important in an English as a Second Language (ESL) setting where language nuance is critical.
- The majority of FC fans are part of a larger HVAC or other appliance that has space constraints and is not free to grow by the two inch diameter (which is really four inch when accounting for housing) as suggested in the NODA. The conversion costs for these types of equipment are not clearly accounted for in the NODA. It was unclear to us how

the latest NODA accounted for these differences. Creating a separate equipment class for FC fans will provide better visibility and create the opportunity to maximize energy savings fans for fans in all equipment classifications.

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.*

MORRISON Response: This was covered in the General Comments, Item 1 above but it bears repeating that starting point for DOE's analysis is based on data that is not consistent with the proposed test procedure and as such, cannot be used as the basis for determining the level of compliance. As stated in the design of the PBER/FEI metric, all fans will have some compliance range, even to EL 5. The question needs to be how large will the compliance bubble be when the various adjustments due to test speed, testing uncertainty, manufacturing variation, selection and sizing are made. Manufacturers need to consider those items to ensure compliance in consideration of enforcement. The data from fan manufacturers (AMCA database used in this DOE analysis) is "typical" and as such half the population would fail to meet the standard. The analysis suggesting that fans with efficiency levels up to EL5 would be available is based on "typical" data that does not include product and test variation. Further, if as the LCC shows, payback would be 2-3 years at the highest EL's, query as to why the "more efficient" fans are not being adopted? Owners and managers of facilities are not foolish and if that good of payback is really true without additional transactional costs, then the "better" fans would be adopted. Likely causes of this questionable payback analysis are the virtually flat cost picture across all EL's along with none of the actual cost to modify equipment based on larger designs. Costs for specialized designs, tooling, application work and tighter tolerances are not accounted for in the analysis and result in no added cost for EL change. Further the faulty starting point doesn't give an accurate compliance bubble and mistakenly shows greater level of compliance than when there is an accounting for the uncertainties. Finally, DOE's assertion that selections can be made within 20% of performance requirements is not consistent with my nearly 30 years of fan experience in meeting the needs of equipment manufacturers. To stay compliant with regulations and keep products safe for consumers, manufacturers generally require less than 2% variation on performance and cannot tolerate changes of 2" in diameter which translate into 4" of housing. That much space is essentially never available in appliances which all have limited room based on consumer needs and cost.

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

MORRISON Response: Basic fan manufacturers and especially small ones like Morrison will be challenged to meet all the requirements in the five year timeframe. At great expense, we will need to retest all our products, retool many, design new and investigate and develop new processes to ensure full compliance. We will also have to develop new website selection program, new literature as well as a new compliance department that will be responsible for reporting the product information to DOE. It is not clear that DOE has included all of these costs in the calculation for manufacturer impact, especially when small businesses are involved. Another challenge will be for the equipment manufacturers to make all the necessary changes in equipment qualification after the fan industry reaches compliance. Given the other regulation burden from DOE on furnaces, air conditioners, package units, walk-in coolers and other as well refrigerant change, it would be highly problematic for all OEM's to make the five year timeline.

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.*

MORRISON Response: As efficiency requirements of fans move ever higher, the move to customized designs will be necessary to meet the standard and that will lead to increased costs for design as well as to produce (smaller volume, greater tooling and product cost). Mass production of high volume products versus customized flexible production for small volume ones greatly affects cost. As efficiency drivers continue to constrain options, smaller volume customized products with greater costs will be used to meet efficiency standards.

Further as higher efficiencies are required, tighter tolerances will be necessary. Tighter tolerances will increase costs for manufacturing parts and assemblies. Tighter tolerances will necessitate the use of stiffer structures for the fan in the appliance to ensure clearance is maintained in the dynamic operation as well as shipping and handling. Stiffer structures are typically accomplished through greater material use or more expensive materials. This will mean higher product costs of material, processing and tooling. Specific amounts will vary depending on the levels necessary to comply. There is no visible accounting for these costs in this NODA.

The MPC scaling illustrated on "MPC vs Diameter" shows cost as a polynomial function of wheel diameter and a scalar for blower type, but only two physical teardowns are used to validate the general curve shape, for just one blower type. Curve fit of a polynomial from two data points is not a sound practice unless the assumption is that the curves go to zero cost and zero-inch diameter and that is clearly not the case. Further, extrapolation beyond the data points available is also pure speculation. The "expectation formed through manufacturer interviews" are not clear to us. Cost for the reasons stated above is not a one dimensional function but a multivariate one.

Finally, the cost to engineer products at ever higher efficiency levels increases exponentially as theoretical limits are approached (and may even be exceeded at the highest EL's when all factors are included). Given the uncertainty around test procedure and other parts of the NODA, it is not apparent these costs are part of evaluation presented in this NODA. Further, the flat cost for all EL's, in virtually all equipment classes, is evidence the increases in fan and product costs are not properly captured.

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

MORRISON Response: All models currently manufactured by Morrison are in scope and will require retesting and evaluation for compliance. Previous guidance was provided. We also anticipate additional models will be needed for any level above EL 1. A multiplier of 2-3 times as many models may be required as levels go up. It should also be noted that there is missing information in the publishing of this NODA in the Federal Register. Footnote 11 is shown in the text where DOE reports that it "incorporated more embedded fans into its analysis for this NODA" (p. 75745) but there is no associated footnote shown. Query as to the source and method of this inclusion or as to how to comment on this issue.

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.*

MORRISON Response: As efficiency moves ever higher, the move to customized designs will be necessary to meet the standard and that will lead to increased costs for design as well as product (smaller volume, greater tooling and product cost). This will lead to an increase in the number of models used and not just a one-for-one relationship. The splitting of models will be on the order of one to two or more. Once again the information DOE used for the NODA comes from data that is not per the recommendations of the ASRAC Working Group and does not provide clear insight into the actual requirements.

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.*

MORRISON Response: Product conversion costs and capital conversion costs will have limited transferability because as efficiencies move ever higher, the move to customized designs will be necessary to meet the standard and that will lead to increased costs for design as well as product (smaller volume, greater tooling and product cost). Further structural (analysis and product) along with process costs will be unique to meet design and application requirements.

The aerodynamic design costs of the fan are only one part of the total cost to redesign the fan leaving aside the cost to redesign the appliance in which the redesigned fan will be installed. Size, sound, tooling, process and repeatability of design also are of importance. Reliability needs to be considered. OEM product space constraints and regulatory approval for safety and performance requirements should be part of any engineering analysis. Other drivers like the acoustical signature must be included as many products must meet code requirements, both indoor and outdoor and especially for schools. All of these costs and time constraints are not transferable and must be considered separately for fan in a given product.

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.*

MORRISON Response: Once again design requirements are unique to the applications they go into. For each product application, including structural needs, the cost for design, product and conversion will be unique.

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.*

MORRISON Response: As efficiencies increase, tighter tolerances are needed and greater control over structure is necessary. With higher class products, greater consideration of dynamic response is required due to higher speed operation so designs will have to be evaluated for structural soundness in light of tighter tolerances.

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.*

MORRISON Response: No comment.

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

MORRISON Response: All of the fans we manufacture will be under consideration for redesign. As the uncertainty of the NODA evaluation presented above is considered, it is not all clear how to evaluate the true consequence of the proposed regulation. Thousands of hours will be needed to evaluate the thousands of applications into which our fans go. All are embedded into appliances which have a range of operation and many fans are embedded into multiple appliances with countless application needs. Analyzing these fans without a finalized test procedure and at the various EL's is a task beyond the engineering resources available to a small manufacturer like Morrison. It was anticipated that DOE and its consultants would evaluate this using the proposed test procedure in a significant sample size covering all applications rather than relying on a database of fan performance data not consistent with the regulation as negotiated and currently proposed.

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.*

MORRISON Response: The vast majority of the fans produced by Morrison are used in some sort of HVACR product. We provided guidance regarding this previously. We do not have any way to evaluate the data presented.

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.*

MORRISON Response: No comment.

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

MORRISON Response: Fan operating hours for HVAC products vary by demand. ASHRAE has representative run time for this type of equipment in commercial applications.

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.*

MORRISON Response: ASHRAE has information regarding fan use in HVAC applications and virtually all are variable load. Demand changes as occupancy, seasons and outside temperature changes.

17. *DOE seeks feedback and inputs on the fan lifetimes*

MORRISON Response: Fan lifetimes are dependent on many variables but the estimate of 30 years would be considered to be a maximum life and not typical. More typical would be 12-15 years for design life of a variable load HVAC fan that does not run continuously. For fans that run continuously, the lifetime of 30 years is extremely long. Further, if fan lifetimes are 30 years, then the 2-3 year payback period shown in the LCC analysis cannot be anywhere near to being right, for who avoids savings that will pay for the product 10 times over or more?

As always, we are appreciative of the opportunity to participate in this rulemaking process. We want to help create sensible solutions that drive systems to better energy efficiency in a cost effective manner so that the best and pareto optimal solutions are adopted.

If you have any questions or wish to discuss this further, please do not hesitate to contact me.

Sincerely,

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