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Trane Comments to CEC Commercial Fans and Blowers

Additional submitted attachment is included below.

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June 15, 2017

California Energy Commission
Docket Unit, MS-4
Re: Docket No. 17-AAER-06
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket No. 17-AAER-06 – Commercial and Industrial Fans & Blowers

Dear Mr. Galdamez:

Thank you for the opportunity to submit comments regarding the development of a Framework for Regulation of Commercial and Industrial Fans and Blowers ('the framework'), presented by the California Energy Commission (CEC) on May 5th, 2017.

Ingersoll Rand (NYSE:IR) advances the quality of life by creating and sustaining safe, comfortable and efficient environments. Our people and our family of brands - including Club Car, Ingersoll Rand, Thermo King and Trane - work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. Our company is helping to solve some of the world's most pressing challenges including the demand for energy resources and its impact on the environment. As such Ingersoll Rand announced in 2014 a roadmap to increase energy efficiency and reduce environmental impact from our operations and product portfolio to result in 20.85 million metric tons of CO_2e avoidance globally by 2020. Most recently, Ingersoll Rand was an original signatory to the "We Are Still In" declaration confirming our commitment to stand by plans that align with the targets set by the Paris Agreement regarding reducing carbon emissions to avert the worst effects of climate change.

Trane is a U.S. and global manufacturing leader of commercial heating, ventilation and cooling (HVAC) products. The invitation to participate document published on May 5th covers fans in a host of applications, including HVAC. For Trane, this would impact a substantial number of products we manufacture; examples include but are not limited to: cataloged air handlers, custom air handlers, variable air volume (VAV) units, commercial unitary air conditioning and heat pump units, Variable refrigerant flow units, fan coils, unit ventilators, air cooled chillers, blower coils and residential air conditioning and furnaces. Collectively, these products account for a significant portion of our company's commercial and residential HVAC revenue. We understand the CEC's interest in promoting energy efficiency through consideration of regulating fan efficiency. However, it is imperative that CEC consider fan applications in their representative end product to achieve possible benefits for the State of California and its consumers, particularly when applied to HVAC products. The intuitive logic that increased fan efficiency will mean overall savings for fan using products does not hold up to scrutiny when applied to HVAC products already regulated by energy efficiency standards.

Significant Considerations for Fans Embedded in HVAC Equipment

We believe consideration of HVAC applications is important to understand the true energy consumption associated with fans used in these systems. Commercial heating, ventilating and cooling accounts for approximately 40% of commercial building energy use. Almost all of these products have their own efficiency descriptors. As a company, and as an industry, these are the efficiency metrics we use when designing and marketing our products, and it is these descriptors designers, engineers and building owners use when specifying our products – this will not change even if fans in HVAC applications are subject to minimum energy performance standards. CEC should take into account the issues summarized below when considering whether standards for fans in embedded applications are appropriate and justified in order to fulfill the energy savings goals of a fan efficiency standard.

- **Existing coverage through California Title 20 and Title 24:** Currently, most HVAC products which could be impacted by any fan standard are within the respective scopes of California Title 20 and Title 24. It is important to note that "within scope" means coverage of product and/or system efficiency, not fan efficiency. Additionally, Title 20 and Title 24 have HVAC system efficiencies and this standard serves as the de facto market minimum efficiency standard for HVAC equipment offered *for sale* by Trane and other manufacturers in the California market. We are required to meet these requirements, and our customers often expect that we exceed them. The energy efficiency requirements in Title 20 and Title 24 serve as an efficiency floor, and these minimum product and system efficiency levels serve as the basis to which we will continue to design. Should a fan standard be imposed, we would continue to design to these product and system efficiency requirements in the most cost effective design methodology. As such, the effect of a fan standard would lead to HVAC products that are no more efficient than their predecessors, but rather optimized around more efficient fans, and therefore **no net energy savings** for these applications.

- **Relationship between fan testing and actual efficiency in application:** For most typical HVAC applications, the tested fan efficiency would not reflect actual consumption unless fan efficiencies were determined via testing in their respective applications. Assuming that improved fan efficiency will result in improved efficiency of products using fans is incorrect.

- **Fan efficiency challenges ability to replace "like for like" fans:** More efficient fans are often larger than less efficient ones. As such, this may increase associated product size. While a similar impeller diameter fan may be available at a higher efficiency, it is imperative to consider that differing fan types have different non-impeller fan geometries and constraints, such that the overall fan footprint increases dramatically. With space constraints being a constant pressure, new products may be too large to replace smaller existing ones without significant design changes and associated costs. Such cost increases would serve to dissuade building owners from purchasing the more efficient fans contained in new products and instead repair existing, less efficient products. Retrofit curbs can be used but they generally come with associated pressure drop which negates any efficiency improvement associated with the more efficient fan. Silencers or plenums add to overall product size, meaning the likelihood that space would be an issue for retrofits increases significantly.

- **Fans less than or equal 1 HP:** Most of the fans in smaller terminal products with motors 1 HP and smaller are integral to the design of the entire casing and cannot be feasibly separated from the product and tested in a traditional stand-alone "bench test". This is particularly impactful for most Terminal Products including Fan Powered VAV Boxes, Fan Coil Units, Unit Ventilators and Water Source Heat Pumps. Additionally, the respective standards developed by the Air-conditioning, Heating, and Refrigeration Institute (AHRI) and its members for these terminal products by which performance is certified includes an energy metric for the complete unit (Watts/CFM). Requiring an additional stand-alone fan test imposes significant additional testing on the industry that is unlikely to provide realistic results. The majority of the Terminal Products mentioned above have direct drive motor and fan assemblies which makes it nearly impossible to perform a test of the standalone fan without the motor.

These considerations manifest the multiple problems a fan-only standard would pose for HVAC and embedded fans in other applications. Therefore, we propose several options the CEC can consider to address embedded fans. These solutions address the energy consumption of fans and blowers in HVAC applications in a more meaningful way. However, no one approach would be an improvement across all HVAC product types listed at the outset of these comments. Nonetheless, if adopted correctly, these revisions represent an improvement over the regulatory approach to fans and blowers for HVAC applications currently found in the framework document.

1. **If the product has an energy metric and is covered by the CEC through Title 20/24 and/or DOE, then it should be out of scope.**

2. **If the product has an energy metric but is not regulated by the CEC, then CEC should:**
    - Consider whether such products use definite or general purpose fans[1]. If the fans are definite purpose the CEC should exclude these from coverage.
    - Consider whether it is possible to use established consensus rating methodologies for HVAC products when determining fan and blower metrics and standards, including AHRI and ASHRAE publications. These efforts could inform how the CEC creates methods of test, metrics and efficiency standards for fans and blowers in HVAC systems.
    - There is interplay between the concept of general vs. definite purpose and fan/blower horsepower. For instance, a horsepower-based exemption would be meaningful for residential HVAC.

3. **If the product does not have an energy metric and is unregulated, then CEC should:**
    - Consider whether such products use definite or general purpose fans. If the fans are definite purpose the Department should exclude these from coverage.
    - Consider whether efforts are ongoing to create efficiency metrics for such products. If so, the CEC could bring such products into the framework when appropriate methods of rating and test for their efficiency exist.
    - As in the comment above, there is interplay between the concept of general vs. definite purpose and fan/blower horsepower. A horsepower-based exemption would be meaningful, but not for all products that fall into this category. Specifically, this would be less meaningful for air handler units than for variable air volume systems or fan coil boxes, all of which are under this category.

4. If the product is a standalone (i.e. general purpose) fan, then the CEC should establish fan efficiency regulation. When there is no application to consider when evaluating a fan or blower's efficiency, this is an appropriate approach.

Finally, given the considerations above, Ingersoll Rand recommends the CEC include definitions for safety, cross flow, circulating flow and induced flow fans, and consider the following definitions for fan, general purpose fan and definite purpose fan:

> *Fan means a device used in commercial or industrial building systems, including a motor and may include controls, to provide a continuous flow of a gas, typically air, by an impeller fit to a shaft and bearing(s). A fan may be manufactured with or without a housing component. A fan is either a "general purpose fan" or a "definite purpose fan."*
>
> *General purpose fan means any fan designed to be used in most general purpose applications.*
>
> *Definite purpose fan means any fan designed in standard ratings with standard operating characteristics or standard mechanical construction for use under service conditions other than usual or for use on a particular type of application and which is not used in most general purpose applications.*

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[1] For the purposes of these comments, we believe a definite purpose fan is one designed specifically for use in an HVAC application, not sold on the general market. A general purpose fan is one sold on the general market and not specifically designed for use in an HVAC system.

For further technical considerations and problems in regulation of stand-alone vs. embedded fans, please see the Appendix at the end of this document.

Specific Exemptions which should be considered in a Fan Efficiency Regulation:

Heat rejection fans for HVAC, air compressors and transportation refrigeration **-** Heat rejection fans are not designed for a specific flow of air. As such, a metric based on air flow is not valid for heat rejection fans. The purpose of a heat rejection fan is to reject heat from a system. They are designed in conjunction with a heat exchanger solely for optimizing removal of heat from a system. Enforcing fan efficiency requirements on these definite purpose fans will require re-optimization of the heat rejection system which won't impact overall system efficiency and building energy consumption. This unfortunately will impact manufacturer design cost, manufacturing cost, and end customer cost with no measurable energy benefit or payback.

A transport refrigeration cooling fan utilizes power derived from a self-powered or vehicle powered engine that drives the entire system. These systems are optimized as a whole to minimize fuel consumption while maintaining its purpose of cooling the trailer or container space. Any changes to fan efficiency will result in a change elsewhere in the refrigeration system to maintain an overall equivalent system. Additionally, with the fans being embedded in the system, enforcement through a Title 20 mechanism will be very difficult to implement and enforce. This is especially true with a mobile system that does not necessarily remain in the state of California.

Economizer Fans – Economizing is a method of free cooling. If done properly, an economizer can save a tremendous amount of energy. During economizer operation, the fan will often operate far to the right of the fan's best efficiency point and thus, less efficiently. However, savings in cooling energy will more than offset the less efficient fan operation.

The design point for an economizer, while not very efficient, enables the economizer to perform its intended function. The individual classes of fans must be examined within this application to truly ascertain the value of the regulation.

If the final rule utilizes an application-dependent approach, we are concerned that economizers may not be able to function to their maximum potential. This increased building energy consumption will jeopardize the energy savings achieved through increased fan efficiency.

Replacement Fans – Fans embedded in equipment such as residential or commercial HVAC have downstream or upstream impacts on airflow distribution. Many applications of this equipment have heating coils and/or natural gas heat exchangers that are developed, tested and certified for safety. When a fan is changed in the field at the application point, an exact model should be used for replacement to comply with safety requirements to ensure that no equipment failure results that may compromise the safety of the building occupants. Ingersoll Rand strongly urges the CEC that replacement fans be exempt from any potential regulation if embedded fans fall under regulation.

Other Issues regarding Regulating Embedded Fans:

Cost to Manufacturers: With any change of a fan that is embedded in HVAC equipment, that equipment, and not the fan, must be re-certified. In other words, if one fan is used in five different capacity/efficiency unitary rooftops, five separate safety, reliability and qualification test plans must be conducted to ensure that safety limits are not exceeded and/or reliability needs are met. Ingersoll Rand urges the CEC to examine the overall burden to the industries utilizing embedded fans prior to inclusion of embedded fans in its regulation.

Timing: Due to the scope of the redesign requirements and applicable testing requirements on equipment utilizing embedded fans, Ingersoll Rand respectively requests that the compliance date for fans which are embedded in equipment be delayed for a minimum of five years to ensure that the industry is allowed time to qualify and test the equipment that require fan changes.

Enforcement: The current scope of Title 20 for appliances is limited in its capabilities to regulate and enforce fan and blower efficiencies in embedded fans in equipment. The requirements for any enforcement would require certification, inspection, and verification of fans installed in equipment out in the field. Because these embedded fans are not standalone products, they are not manufactured or shipped into California as a single product. As such there is no mechanism that would not be burdensome for the CEC to enable regulation enforcement.

Ingersoll Rand has a long history of working collaboratively and constructively with the California Energy Commission and looks forward to conversations on our comments and others. We will be happy to further engage with the CEC to elaborate on our comments or provide additional background.

Sincerely,

Jill C Hootman

Jill C. Hootman
Manager, Unitary Product Planning

Appendix to Docket No. 17-AAER-06 – Commercial and Industrial Fans & Blowers
Ingersoll Rand Comments dated June 15, 2017

The comments below include more technical information to be considered with regard to regulating fans and blowers as related to HVAC applications.

Standalone fans vs. Embedded fans: Test and rating standards are created to ensure uniformity amongst manufacturers thus affording system designers and equipment manufactures consistent data for evaluation. ANSI/AMCA Standard 210 (ANSI/ASHRAE Standard 51), "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating," was created for fans which are used as a general purpose component and is undoubtedly the industry standard for fan airflow performance. However, once a fan is installed in a cabinet (e.g., an air-handling unit or a packaged rooftop) a number of factors can influence performance. Known generally as "system effects," many of these factors can be approximated, but the combinations must be tested for accurate performance. Some common "system effects" include:

- Cabinet proximity;
- Component proximity (coils, filters, internal control enclosures, etc.);
- Motor proximity;
- Bearings, sheaves, and other drive components; and
- Discharge orientation.

Equipment test and rating standards are created to include these effects. For example, AHRI Standard 430 describes the test and rating requirements for central station air-handling equipment. An equipment standard will provide the most accurate estimate of final, in situ performance. In the absence of an equipment standard, a fan that has been tested and rated in accordance with AMCA Standard 210, coupled with any appropriate systems effects (reference Publication 201 from the AMCA Fan Application Manual), should be used.

The cabinet's effect on a fan can be quite significant. Addressing these effects can have as much, if not more, influence on overall energy use than addressing fan efficiency itself. By considering the equipment a fan is mounted in, additional energy savings can be realized.

Blow through vs. Draw through configured fans: The location of the fan relative to other components is another important factor. When components are located downstream of the fan section, unhoused fans will generally use less energy than a housed fan. However, some components require a specific velocity profile—gas heat exchangers and electrical heating elements for example. Thus, we recommend the CEC take an approach similar to AHRI Standard 430 with different unit orientations having different efficiency targets.

Standalone fan efficiency vs. embedded fan efficiency: With the differences between embedded fans and standalone fans it is helpful to examine an example where a more efficient fan could be required in place of a less efficient, more compact fan. Examples of this situation include an airfoil (AF) fan required in place of a forward curved (FC) fan or a larger diameter fan required in place of a smaller fan. If a metric based on peak efficiency is implemented, an equipment manufacturer may need to use a smaller diameter fan than what might have been used otherwise. Although the smaller diameter fan may have a higher peak efficiency, the actual operating efficiency could be worse as a result of the smaller diameter. Even with a higher bare fan efficiency, the increased cabinet spacing required for the less compact AF fan or the larger diameter fan could negate the increase efficiency—with increased cost to the consumer.