DOCKETED	
Docket Number:	17-AAER-06
Project Title:	Commercial and Industrial Fans & Blowers
TN #:	224815
Document Title:	Ingersoll Rand Comments on CEC Draft Staff Report, Commercial and Industrial Fans & Blowers
Description:	N/A
Filer:	System
Organization:	Ingersoll Rand
Submitter Role:	Public
Submission Date:	9/28/2018 2:11:23 PM
Docketed Date:	9/28/2018

Comment Received From: Ingersoll Rand
Submitted On: 9/28/2018
Docket Number: 17-AAER-06

Ingersoll Rand Comments on CEC Draft Staff Report, Commercial and Industrial Fans & Blowers

Additional submitted attachment is included below.

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September 28, 2018

Mr. Alejandro Galdamez
California Energy Commission
Docket Unit, MS-4
1516 Ninth Street
Sacramento, CA 95814-5512

Re: Docket No. 17-AAER-06 – Draft Staff Report, Analysis of Efficiency Standards and Test Procedures for Commercial and Industrial Fans and Blowers

Dear Mr. Galdamez:

Thank you for the opportunity to comment on the California Energy Commission (CEC) Draft Staff Report, Analysis of Efficiency Standards and Test Procedures for Commercial and Industrial Fans and Blowers, published on June 11, 2018 (CEC Draft Staff Report).

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. 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. As such, we are eager to work with the state of California as it seeks to meet its 2030 goals of doubling building efficiency and reducing overall emissions by 40 percent of 1990 levels.

While Ingersoll Rand is not a manufacturer of standalone fans, the proposed standards in the CEC Draft Staff Report will have an enormous impact on the design and application of our products, notably in our commercial heating, ventilation, and air conditioning (HVAC) and air compression business segments. For a significant portion of our global portfolio, purchased fan components or assemblies are subcomponents of our fan system designs, which are part of the finished products we manufacture for sale, and they serve the purpose of either providing conditioned airflow to a space or rejecting heat. The CEC Draft Staff Report proposes to regulate fans including supply, condenser, relief, exhaust, and return fans embedded in commercial unitary air conditioners larger than 760,000 Btu cooling capacity; relief, exhaust and return fans embedded in unitary air conditioners and heat pumps smaller than 760,000 Btu cooling capacity; condenser fans in air-cooled chillers; and heat rejection fans embedded in air compressors. These products must already meet energy efficiency requirements per existing California regulations, with the exception of air compressors, which are currently undergoing a separate rulemaking process under California Title 20 to regulate product efficiency. All of these products are comprehensively engineered to optimize system-level performance – including energy efficiency – and changes to the size or operation of any one component can require re-optimization, and even complete redesign, of the entire finished product to achieve the same level of performance.

Ingersoll Rand is convinced that a component-level focus on embedded fans and blowers will miss the greater energy savings opportunity that presents itself. We strongly urge the CEC to exclude fans embedded in commercial unitary air conditioners and heat pumps, commercial air-cooled chillers, commercial and industrial air compressors, and transport refrigeration equipment from the scope of regulation for commercial and industrial fans and blowers. Instead the Commission should focus its regulatory efforts on the product- and system-level energy efficiency requirements applicable to these products. Doing so will yield significantly larger energy savings, while simultaneously avoiding the negative, unintended consequences that will result from product re-optimization in order to comply with a fans standard. Maintaining a product or system-level approach will guarantee improved energy efficiency as standards increase, and ultimately allows the manufacturer to design optimal solutions to meet these requirements. In instances where a federal standard is not in place, but where a product must otherwise meet requirements under ASHRAE Standard 90.1 or California Title 24, Building Energy Efficiency Standards for Residential and Non-residential Buildings (Title 24), we encourage the CEC to increase minimum efficiency standards. For products where federal standards preempt state standards, CEC can still address fan efficiency requirements in the context of the building system through the fan power limitation requirements in Title 24.

Issues Regulating Fans Embedded in Products Already Optimized for Energy Efficiency

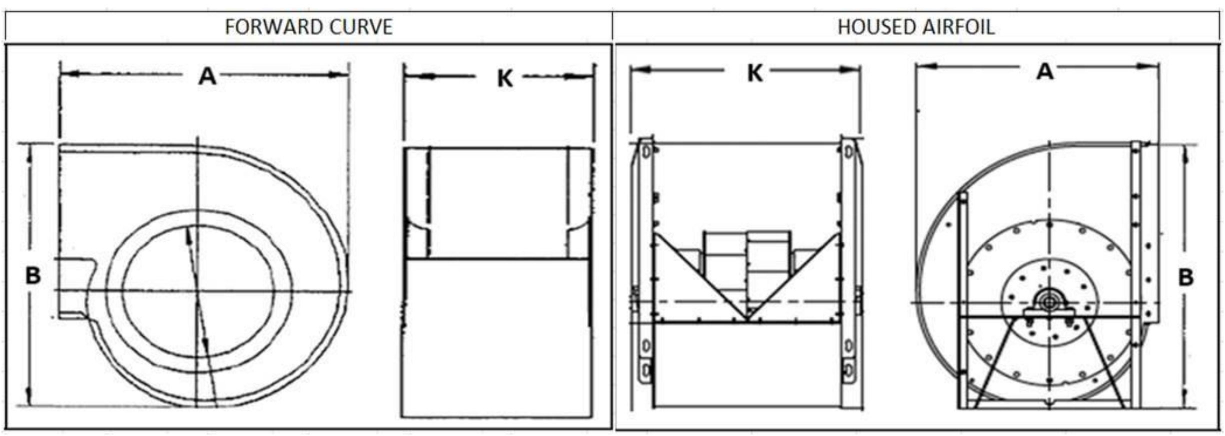
The most significant issue as it relates to regulating embedded fans is that for many fan types, improving fan efficiency requires increasing the diameter or housing of the fan. The CEC has suggested that alternative fan designs and types are available to alleviate this issue, but for a wide variety of HVAC systems and air compressors, such alternatives are simply not applicable or viable. The impact of increasing the footprint on the design of the finished product varies significantly; for space-constrained products such as unitary air conditioners and air compressors, changing the size of the fan can mean complete system re-design. Regulating these embedded fans will have a paradoxical effect on systems efficiency, as the finished product will be re-designed back to a similar product efficiency level in order to save costs elsewhere, thus nullifying the energy savings from the fan.

<u>Relationship between Product Design, Fan Footprint, and Fan Efficiency</u>

In the design of packaged unitary HVAC equipment, the engineer chooses the supply and exhaust fans by selecting the most effective centrifugal housed or unhoused fan which will fit inside the unit’s cabinet. These centrifugal fans are often selected specifically for this application, and are the most efficient fan options for discharging supply air into ductwork or downstream components. Often the optimal choice is to use forward curve (FC) fans in these applications, given their ability to utilize a relatively small fan housing and that they tend to be efficient at high flow and low static pressure operation. Condenser and heat rejection fans – which do not provide measurable airflow to a space – are selected as part of a condenser section or heat rejection subsystem design, and must balance section or subsystem size and control strategy, in addition to fan efficiency, in order to optimize for product system efficiency.

In order to improve the Fan Energy Index (FEI) of the fans embedded in our products, we have three options: (a) increase the diameter of the fan; (b) change the fan type from FC to airfoil (AF), assuming the current fan is FC; and/or (c) restrict the operating map of the fan to within the envelope of a given FEI. All three of these options will have a tremendous impact on the system-level design and performance of the product. Increasing fan diameter or moving from an FC to an AF fan will increase the footprint of the fan housing (or scroll), and in many designs, the larger fan simply will not fit in the space allotted. Even if the fan will fit geometrically, the larger footprint changes the relationship of the fan to other upstream and downstream components, such as evaporation coils, condenser coils, and other heat exchangers, which will see reduced performance due to less uniform airflow. Reducing the fan operating map – the last option identified, will yield either a nonfunctional finished product or one which cannot meet needed operating conditions, including modes such as system economizing. These issues are discussed in more detail in the product examples section of these comments.

Fan Footprint Comparison: Unitary Supply Fans offered by Lau

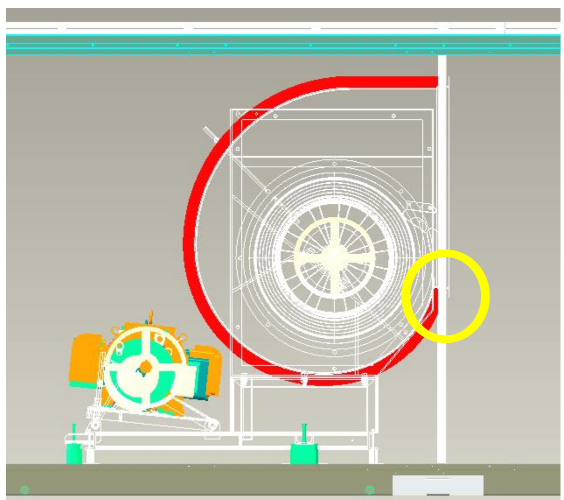


	Forward Curve		Housed Airfoil	
Diameter	**18”**	**20”**	**18”**	**20”**
Depth (A)	27.0”	32.3”	29.5”	32.1”
Height (B)	29.2”	35.8”	35.8”	39.1”
Width (K)	21.9”	22.8”	29.0”	32.8”

Source: Lau commercial catalog

In the CEC Draft Staff Report, one example is cited in which the FEI of a fan can be improved without having to increase its diameter or housing. In this example, a 27” centrifugal square inline fan is compared to a 27” mixed flow inline fan; the mixed flow fan has a higher FEI but is the same diameter. This example, however, is not relevant to packaged unitary HVAC applications. Unlike centrifugal housed or unhoused fans, inline fans are designed and rated for blasting air down lengthy ductwork, and are not intended for placement inside of packaged unitary equipment which are space-constrained and have many downstream components. Using these fans in unitary equipment would dramatically decrease their energy performance and still require system redesign.

During the U.S. Department of Energy (DOE) rulemaking process to establish Energy Conservation Standards for Commercial and Industrial Fans and Blowers, DOE analysis relied on two inaccurate criteria to determine the “equivalence” of FC centrifugal housed and unhoused fans in the fan selection process. First, DOE assumed that a limited fan diameter increase of not more than 2” would yield an equivalent fan; second, DOE assumed that a 20% decrease in airflow and/or static pressure would yield equivalent fan performance. Regarding the first assumption, a 2” increase in fan diameter does not mean a 2” increase in overall fan footprint, as the complete fan housing is typically an additional 60-80% of its diameter. As an example, increasing a FC fan diameter by 2” will mean a fan footprint increase of roughly 3.5” in height, width, and/or depth. As demonstrated by the figure below of an example supply fan in a unitary air conditioner, even a modest increase in fan footprint of 3.5” can interfere with other components, such as the fan motor, indoor coils, the fan wall, or the cabinet, and subsequently require entire product redesign.



In this generic unitary air conditioner example, an increase in scroll width of 3.5" interferes with the fan wall.

Regarding the second assumption, it is dramatically inaccurate to assume that a fan which provides a 20% decrease in airflow or static pressure is the “same” functional fan. Our customers specify product design points to provide needed airflow at a given static pressure – these requirements do not have a 20% tolerance and customers simply will not accept that level of deviation. Per AHRI Standard 340/360, the airflow supplied by the rooftop unit must be within ±3% of the rated airflow.

Ultimately, implementing a regulation that requires an FEI for embedded fans can necessitate complete system re-optimization or redesign of equipment already optimized for energy efficiency, the impacts of which are significantly underestimated – if accounted for at all – in the DOE and CEC analyses of the proposed standards.

Negative, Unintended Consequences of Component Regulation

The finished products in which many of the fans within the scope of the CEC Draft Staff Report are embedded are designed to provide a service to the end user, as efficiently as possible, while meeting a competitive price point. Component selection, which includes the fans, occurs as part of a system design process where all of these factors are weighted to produce a fully optimized finished product. If the product design process is limited to only a subset of more efficient, but larger and more expensive fans, tradeoffs must be made elsewhere. Net gains in energy savings are not realized.

Increased Cost of Finished Products for Little-to-no Efficiency Improvement

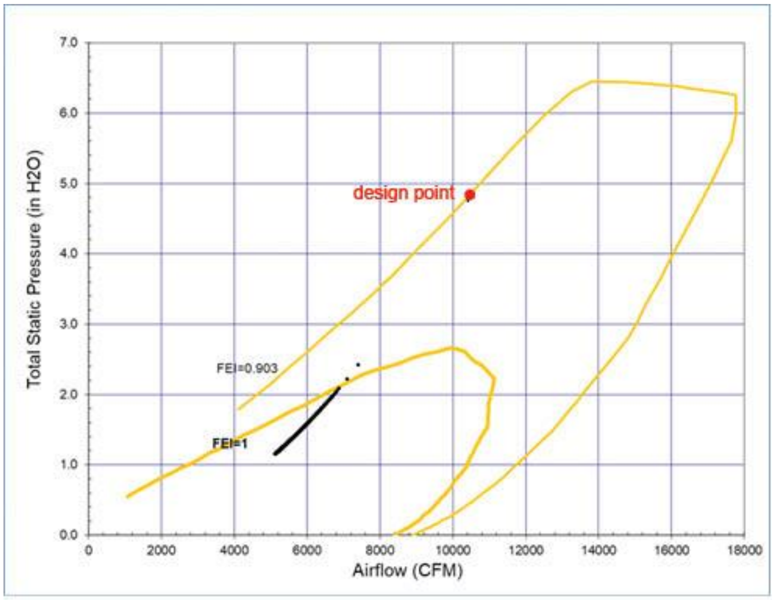
As previously stated, changing an embedded component of a product – and fans in particular – can require product re-optimization and re-design. Trane unitary air conditioners and Ingersoll Rand air compressors are already optimized for performance and cost, so a revised design will yield a sub-optimal product cost-effectiveness. Trane has conducted a comprehensive assessment of the embedded fans in its commercial unitary products that would be impacted if CEC's Draft Staff Report were enacted as regulation. When accounting for the increased cost of the fans, fan structure, increased cabinet size, and re-design and engineering costs, we expect to see an average price increase for these products in California of $257 per cooling ton[1], or 28% higher than today. Air compressors, which can be even more space-constrained, would likely see a similar cost impact.

If changing an embedded fan necessitates the re-optimization or redesign of Ingersoll Rand's products, we will be forced to make trade-offs within the design of the product itself in order to keep it at as cost-competitive a price point as possible. For products which must already meet an energy performance metric that captures the fans, including the majority of fans in large commercial unitary air conditioners and air compressors, this will mean an energy-neutral change to the overall performance of the product. As an example, if a Trane large commercial air conditioner must be redesigned to accommodate a larger supply fan, downgrades to the compressors and/or heat exchangers would have to be made in order to control costs. The new product would have a similar Integrated Energy Efficiency Ratio (IEER) – washing out the energy savings from the supply fan – but would be larger, more expensive, and sub-optimal.

Further, fans which are used in variable air volume (VAV) systems, which account for the majority of new and replacement package HVAC systems sold in California, operate at a range of airflow rates and total static pressure. This provides a significant benefit over constant volume systems, as the system has greater control over the modulation of space conditioning, allowing the system to save energy through reduced fan speed/airflow rather than on/off cycling. The design (or selection) point for a VAV fan is the same for a constant volume fan, typically the point of maximum cooling demand for the system. However, the majority of operating points occur at lower airflow rates and total static pressure along the fan curve, reducing the electrical consumption of the fan.

[1] Additional data to substantiate this estimate will be provided to the California Energy Commission pending a Confidentiality Agreement.

The image below depicts the certified operating ranges of a generic FC fan at FEI = 1.0 and FEI = 0.9. Each black dot is an hourly operating point for a year-long simulation of a VAV supply fan in a unitary air conditioner, serving a building in Sacramento, CA, using Trane TRACE software. At the fan design point – the point of annual maximum cooling demand for the air conditioner – the supply fan operates at an FEI of 0.903. However, because this is a VAV fan with a wide turn-down ratio, it operates over 95% of the time at an FEI of 1.0 or better, accounting for over 85% of the fan's total energy use.



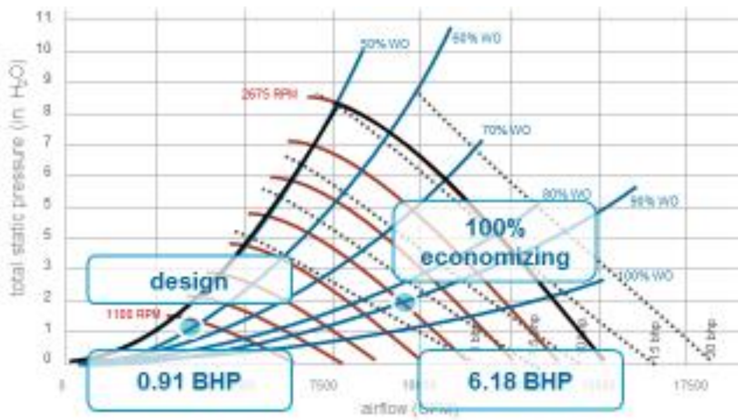
Generic VAV FC supply fan

Moving to a fan with a design point FEI ≥ 1.0 will only yield meaningful energy savings at the operating points that account for around 15% of the current fan's energy use. The remaining operating points will also see an improvement in FEI, but the incremental energy savings at those points will be substantially lower.

Limitations on Product Utility

Fan efficiency is only one factor in the selection process when designing a product made up of several components critical to its energy performance. In some cases, the efficiency of the fan itself can be sacrificed in order to achieve larger system-level efficiencies elsewhere. Perhaps the best example of this can be seen in the economizing function of a unitary air conditioner. Today these products are designed to provide "free cooling" wherever possible; when the outdoor ambient temperature and humidity is in a comfortable range, the air conditioner's compressors are throttled or shut off completely, and the unit increases the amount of outdoor air provided to the space. This function requires that the relief or return fan(s) increase its airflow at lower static pressures, thus operating in a less efficient region of the fan map and often outside of a 1.0 FEI range. However, the energy savings resulting from reduced or no compressor use far outweighs any increase in consumption from these fans. Regulating relief or return fans in unitary air conditioners to a point where economizing is less feasible will increase the energy consumption of the unit in its building system application.

For example, suppose a rooftop unit is set up as an exhaust fan economizer system with a central supply fan and a central relief fan. 10,000 CFM is required to condition the space and the ventilation requirements are about 4,000 CFM. During design point operation, the unit returns 6,000 CFM and exhausts 3,500 CFM to maintain proper building pressurization. However, during full economizing, the unit will supply 10,000 CFM of ventilation air and must exhaust 9,500 CFM. Notice that the two operating points span almost the entire fan map. The fan needs to be sized small enough to handle the design operating point but it also needs to be selected with a wide enough operating range to handle the 100% economizing operating point.



Dual-purpose relief fan operating map as described in the example above.

Depending on the building type and climate, the unit will generally operate somewhere between these two points but substantial operation will be at or near the design system curve. It’s worth noting that the unit may never actually run in 100% economizing mode, especially if controlled as a VAV system. The necessarily wide operating range of economizer fans cannot be overlooked if system efficiency is the end goal. Appropriate energy optimization may require estimated annual run hours with associated fan duty points.

Additionally, FC fans – which have narrower allowable operating ranges than AF fans at a given FEI – have much larger “turn down” ratios, giving them the ability to operate a lower airflow rates without stalling. This is especially useful in multiple-zone VAV applications, as equipment utilizing FC fans will have greater control over the modulation of space conditioning, when compared to equipment using AF fans. This system utility will be hampered if commercial HVAC equipment is forced to shift from the use of FC fans to AF fans as a result of fan efficiency regulation.

Delayed Transition to Next-generation Equipment

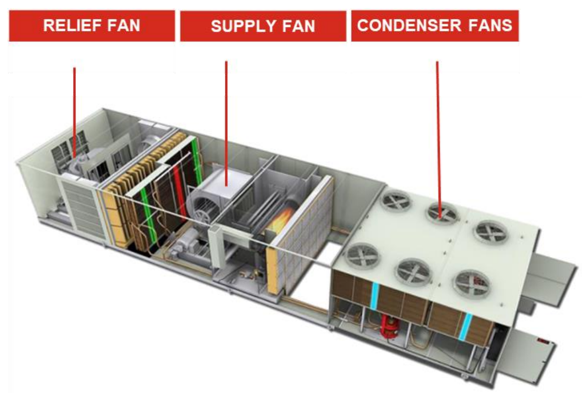
The opportunity to improve the energy and environmental performance of unitary air conditioners and air compressors by focusing on their embedded fans pales in comparison to Ingersoll Rand’s wider areas of innovative focus. At present, the Trane commercial unitary product team is focused on maintaining a tiered offering of products to meet and exceed well beyond the energy efficiency requirements for IEER set to take effect in 2023 per DOE appliance standards. Additionally, all of these products will be compatible with alternative, low-global warming potential refrigerants by 2023 in anticipation of regulations to be promulgated by the California Air Resources Board (CARB) under the direction of SB 1013. Meanwhile, Ingersoll Rand's air compressor teams have been focused on launching and improving upon a next-generation line of products designed to exceed energy efficiency regulations either at the U.S. or California level.

These products will help our customers in the State of California reduce their energy use and lessen their GHG footprint regardless of what fan is embedded inside of them. As stated above, changes in fan selection will have little-to-no impact, and in some cases even a negative impact, on the energy performance of products that are already designed to meet an energy efficiency requirement. If we are forced to redesign these products in order to accommodate a different fan, it will undoubtedly slow our ability to bring these solutions to the marketplace, especially those which exceed product minimum efficiency regulations. The substantial increase in price of these products resulting from the use of a different fan will make it more difficult for consumers in California to purchase the equipment, further slowing the transition to next-generation products.

Specific Impacts on Ingersoll Rand Products and Proposed Alternatives

Trane Intellipak Unitary Air Conditioner, 70 tons

This commercial unitary air conditioner is part of the Trane Intellipak 1 product family, which offers packaged rooftop units up to 130 cooling tons (1,560,000 Btu). These products provide space conditioning to large or complex commercial buildings, such as a mid-size office or laboratory. As these air conditioners are larger than 760,000 Btu in cooling capacity, the CEC Draft Staff Report recommends regulating all fans embedded in the product, including the condenser, supply, relief, exhaust, and/or return fans.

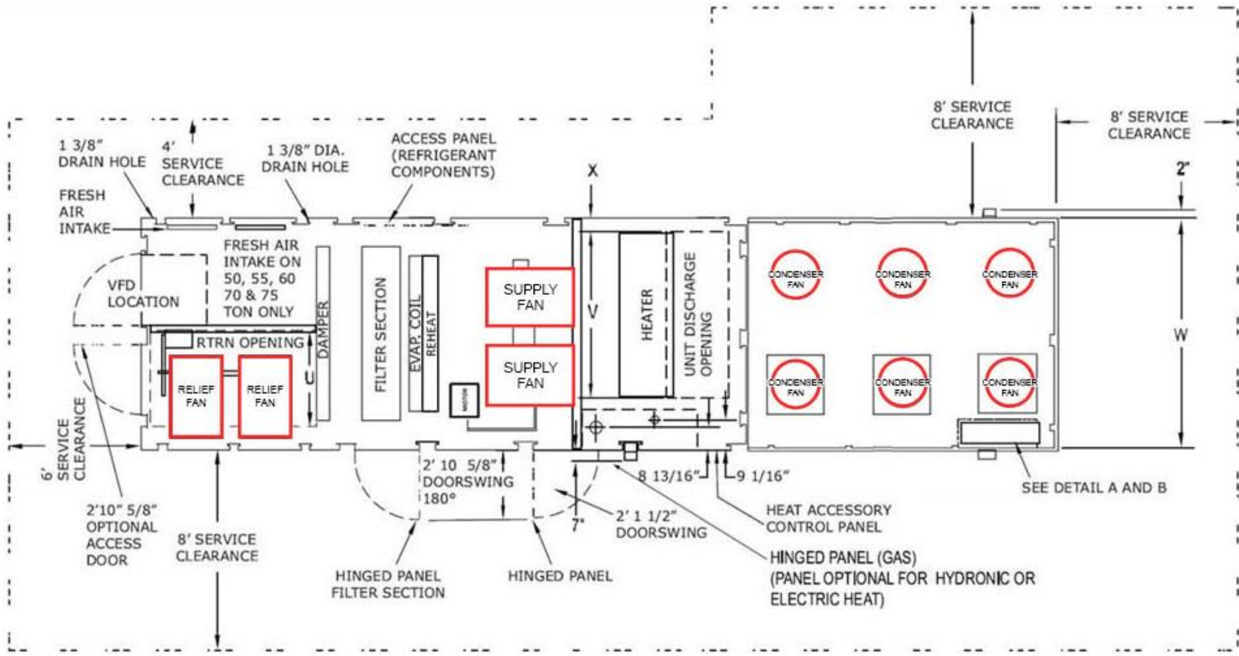


Shown above is a 100 ton Intellipak 2, which is has a larger cooling capacity than the 70 ton Intellipak 1, but is also illustrative of unitary air conditioners that will be impacted by the proposed regulation.

This 70 ton Intellipak example contains the following fans:[2]

	# of Fans	BHP	% of Unit Energy Consumption	Change Required
Condenser	6	0.92	5.2%	No (<1HP)
Supply	2	4.65	12.4%	Yes
Relief	2	3.68	3.6%	Yes

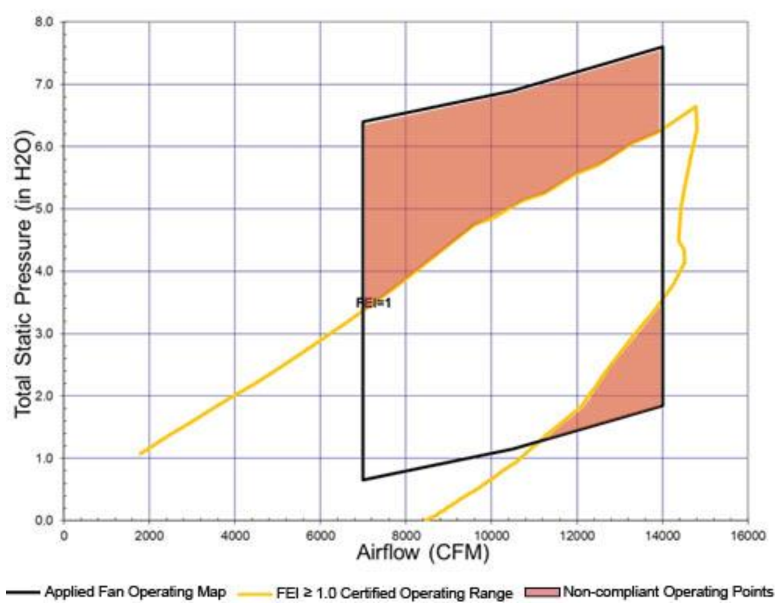
[2] Fan attributes and share of unit energy consumption has been revised since Ingersoll Rand's presentation at the June 11, 2018 CEC Staff Workshop, as Trane has had additional time to review current fan properties, re-calculate performance at appropriate selection points, and refine system analysis.



Top view of a 70 ton Intellipak 1 unitary air conditioner

Fan selection: Supply Fans

The 70 ton Intellipak currently uses two identical 22" VAV FC fans positioned in parallel. A representative fan curve is shown below; the black outline represents the fan's required operating map and the yellow outline represents a certified operating range for this fan in order to maintain an FEI ≥1.0:



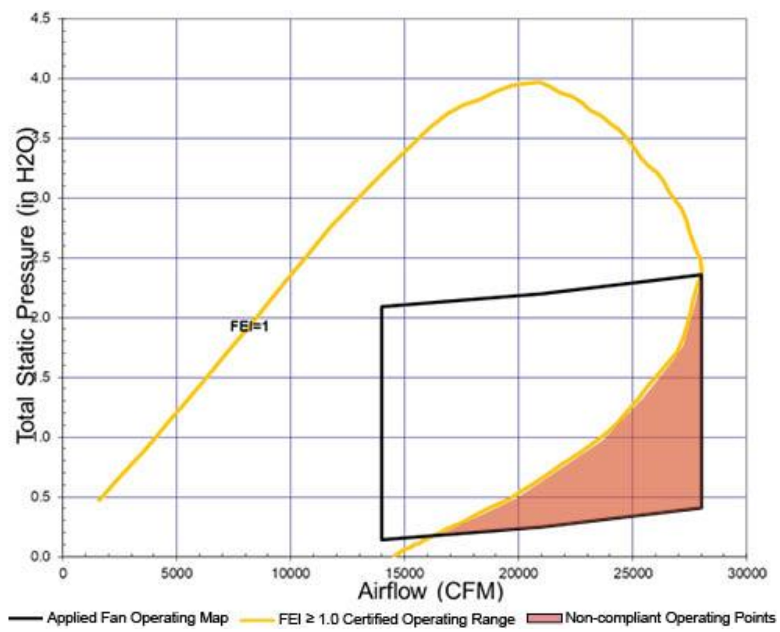
Since the operating map for the existing supply fan falls partially outside of the FEI ≥1.0 certified operating range, new fans must be selected. Moving to a 25" FC fan will move the contours of the FEI range to the left and right, but not up, and therefore will remain non-compliant for the needed operating map. A compliant fan closest in geometry will likely be a 22" AF fan.

Because of the footprint of the AF fans, it is possible that the new supply fans will not fit in the space allotted. The designer can attempt to raise the fans over top of the drive, however the increased height of the fans may interfere with the top of the cabinet. Even if the new supply fans can fit in the space, the changes in size will disrupt the relationship to the evaporation coils and the heater, both of which will become less effective as the uniformity of airflow across those elements is decreased, and ultimately they too will need to be rearranged. Further, replacement of the fan will require re-qualification of all electric and gas heating elements to ensure safe operation, as well as customer sound data testing to ensure acceptable acoustical performance. Neither of these efforts are trivial, an enormous time and resource expense will be required to complete this level of testing.

The incremental fan costs, product re-optimization or redesign, and certification testing will all contribute to the significantly higher product cost.

Fan Selection: Relief Fans

The 70 ton Intellipak uses two 20" VAV FC relief fans to discharge air and maintain balanced building pressure. A representative fan curve and operating map for the relief fans is shown below:



Just as with the supply fan, replacing the current 20" FC relief fans with 22" FC fans or 20" AF fans, as would be needed to improve the FEI, will require system re-optimization. Seeing as the relief fans are even more space-constrained than the supply fans in the 70 ton Intellipak 1, there is an increased likelihood that the entire product will need to be redesigned with a larger cabinet size. Further, it is possible that a 22” FC fan or 20” AF fan 1.0 FEI certified operating map will still fail to cover the entire operating map of the relief fan, meaning design points would need to be restricted. Especially concerning is that the potential non-compliant points are at high airflow and low static pressure, which as stated in the previous section, are typically needed when the system is providing free cooling. As a result, the 70 ton Intellipak may have fewer operating points at which it can operate in economizing mode, and total system energy use in application will increase.

Energy Savings

It is not possible to calculate the actual energy savings attributable to the new fans until the Intellipak is redesigned and fan operation is simulated. However, we can estimate the energy savings by calculating the reduction in horsepower needed for each fan to achieve a 1.0 FEI rating, and converting this change to savings in kWh. In the 70 ton Intellipak example, this exercise produces *theoretical* energy savings of 4,943 kWh per year.[3]

It is critical to consider however that the above energy savings estimation does not consider the system effects that will dramatically reduce the total energy savings resulting from the fan upgrade. In order to keep the cost and size of the unit as reasonable as possible, if we must redesign the 70 ton Intellipak to accommodate the new fans, tradeoffs will be made elsewhere in the system to produce a unit with a similar IEER. For unitary air conditioners, this will mean that the energy savings resulting from the improved supply fans – which contribute to the IEER rating – will be offset by downgrades to the refrigeration system. Additionally, the energy savings does not consider the potential loss in free cooling operation, due to the restriction on the relief fan operating map, which will result in a further decrease of the system energy savings.

Incremental Costs

As discussed in the *Negative, Unintended Consequences of Component Regulation* section of these comments, Trane estimates an average cost increase of $257 per cooling ton will be necessary to recoup the costs of upgrading all in-scope fans in its commercial unitary portfolio and resulting product changes. Therefore we estimate that the cost increase of the 70 ton Intellipak will be $17,990.

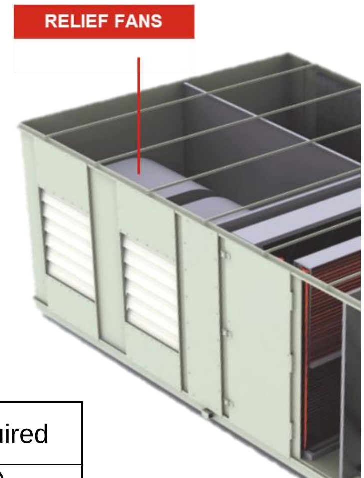
Proposed Alternative: Address the IEER for Commercial Unitary Air Conditioners >760,000 Btu

Rather than pursuing component-level regulation in Commercial unitary air conditioners >760,000 Btu (>62.5 tons), CEC should continue addressing the energy efficiency of this equipment at the product level. Unitary air conditioners >760,000 Btu are not pre-empted by federal appliance standards, and CEC could revisit the IEER requirements for these products in Title 24 Table 110.2-A. Raising these IEER levels to a reasonable level would yield more energy savings in this product class, at less of an

[3] Additional data to substantiate this calculation on a fan-by-fan basis will be provided to the California Energy Commission pending a Confidentiality Agreement.

incremental cost to consumers in California, provided that its embedded fans do not have to meet specific energy efficiency requirements.

<u>Trane Intellipak 1 Unitary Air Conditioner, 40 tons</u>



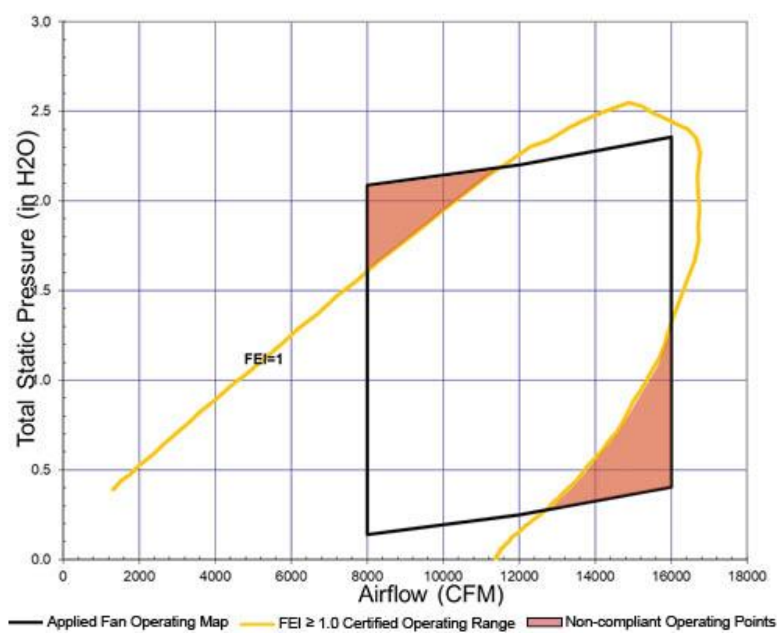
This commercial unitary air conditioner is also part of the Trane Intellipak 1 product family. However, since the air conditioner is less than 760,000 Btu in cooling capacity, its product-level energy efficiency requirement is covered by DOE appliance standards. The CEC Draft Staff Report recommends regulating the relief, exhaust, and/or return fans embedded in this equipment.

This 40 ton Intellipak example contains the following fans:

	# of Fans	BHP	% of Unit Energy Consumption	Change Required
Condenser	4	0.39	4.5%	No (excluded)
Supply	2	1.76	10.0%	No (excluded)
Relief	2	3.55	3.6%	Yes

Fan selection: Relief Fan

The 40 ton Intellipak uses two 18" VAV FC relief fans. A representative fan curve and operating map is shown below:



Similar to the relief fan in the 70 ton Intellipak, a new fan will need to be selected to accommodate the needed operating map, likely a 20" FC fan or 18" AF fan. Space constraints are similar for the relief fans in the 40 ton Intellipak – they are bounded by the unit's cabinet wall and filter section on the sides and controls behind, so product re-optimization or redesign will be necessary.

Energy Savings

Using the same methodology as the 70 ton example, we can estimate the energy savings from the relief fan by calculating the reduction in horsepower to achieve a 1.0 FEI rating, and converting this change to savings in kWh. In the 40 ton Intellipak, the estimated *theoretical* energy savings is 2,373 kWh per year.

Incremental Costs

Using the $257 per cooling ton estimate for Trane's commercial unitary portfolio, the estimated cost increase for the 40 ton Voyager 3 is $10,280.

<u>Ingersoll Rand R-series Rotary Screw Air Compressor, 75 kW</u>

The Ingersoll Rand R-series 75 kW air compressor is used in industrial settings and provides process air to operations such as manufacturing and food processing. These rotary air compressors contain an embedded fan which is used for heat rejection; the Draft CEC Staff Report is not clear on whether this fan is within the proposed scope. Importantly, the electrical consumption of the fan is captured by the air compressor's Isentropic Efficiency rating, which is used to evaluate energy performance of the product per the U.S. DOE Test Procedures for Commercial and Industrial Air Compressors.

The 75 kW air compressor contains one fan:

	# of Fans	BHP	% of Unit Energy Consumption	Change Required
Heat Rejection	1	2.6	2.5%	Yes

Design Challenges

Heat rejection fans for air compressors, like most fans used for this purpose, are not specified based on the amount of airflow provided to a space at a given static pressure, and therefore FEI is not a relevant metric for evaluating their efficiency. For this reason, it is difficult to estimate the impact that the proposed regulation in the CEC Draft Staff Report will have on the finished product. However, like unitary air conditioners, air compressor designs are highly space constrained in order to minimize unit footprint and material costs. If a fan efficiency requirement requires the use of air compressor heat rejection fans with larger footprints, it will also likely necessitate equipment redesign and re-optimization. For this air compressor, product redesign will require a larger fan and blower box, a larger heat exchanger and increase in cooling fluid, and a larger product enclosure, all of which will add significant cost.

Energy Savings

The 75 kW R-series rotary air compressor contains one 2.2 kW heat rejection fan. Assuming the typical 4,000 hour per year duty cycle for this equipment, and a 10% improvement in fan efficiency, the resulting *theoretical* energy savings is 800 kWh per year.

Also similar to the unitary air conditioner, the energy savings from regulating these fans are only theoretical as the electricity consumed by the fan is already accounted for in the product's efficiency rating. Any increase in Isentropic Efficiency resulting from the improved heat exchanger fan are likely to be offset by design trade-offs made elsewhere in order to control the cost of the finished product.

Proposed Alternative: Address the Isentropic Efficiency for Commercial and Industrial Air Compressors

Ingersoll Rand recommends that the CEC explicitly exclude air compressor heat rejection fans from the scope of this regulation. Rather than regulating these fans, we suggest that CEC continue in its consideration of Energy Conservation Standards for Commercial and Industrial Air Compressors, under Docket # 18-AAER-05. The latter approach will achieve energy savings at the product level and will avoid the burdens and consumer costs of component-based regulations.

Additional Comments on the CEC Draft Staff Report

<u>Fans Embedded in Transport Refrigeration Equipment</u>

Ingersoll Rand's interpretation of the Draft Staff Report is that all fans embedded in transport refrigeration equipment, including hybrid-type transport refrigeration units (TRUs) capable of plug-in electrical operation, are considered by CEC to be outside the scope of the proposed regulations. We strongly support this exclusion and urge CEC to maintain it in any final regulation. Similar to the other finished products discussed in these comments, the energy consumption of fans in transport refrigeration are also captured by an efficiency metric – in this case a diesel emissions standard required by CARB. Plug-in hybrid TRUs account for roughly 5% of the California TRU market, are plugged in for roughly 10% of operation, and its supply fan accounts for 5.25% of system power, thus making any attributable savings from a fans regulation essentially *de minimis*. However, a regulation that forces redesign of the equipment – expected should these fans be included in scope – would upend not only the market for plug-in TRUs but also the CARB roadmap to transition long-haul trucking toward electrification.

<u>Replacement Fans</u>

Should the CEC conclude to regulate embedded fans in unitary air conditioners and heat pumps, chillers, or air compressors despite the issues raised in these comments, it is necessary that replacement fans for existing equipment be exempted from this standard. As indicated in each embedded fan example provided, we expect that in most applications a 1.0 FEI fan will not fit within the existing product structure. Such an exemption will protect consumers in California from the extreme burden of replacing an entire product when only a fan needs to be replaced. Further, should consumers be faced with this issue, we expect that many will attempt to circumvent product replacement by making alterations to the existing equipment in order to accommodate a fan which complies with the regulation, but is not certified for use in the product. This not only poses a threat to the efficiency and functionality of the product, but also potential safety issues. As an example, many unitary air conditioners also contain a gas furnace to provide space heating. Changing the airflow path over a gas heat exchanger can create hot spots in and around the unitary equipment, which can result in combustion of the product.

Compliance Date

A one year compliance date as proposed in the CEC Draft Staff Report is not reasonable for embedded fans. At Ingersoll Rand, typical product redesign cycles range 5-7 years; for products which must be redesigned as a result of regulations on their embedded fans, a one year compliance period will mean significant gaps in product availability across the industry. Ingersoll Rand maintains that for unitary air conditioners and heat pumps, chillers, and air compressors, regulating embedded fans will be highly burdensome no matter the compliance period, and will likely lead to product availability gaps among our higher-efficiency product tiers. For all other fans embedded in HVAC equipment, such as catalog air handlers and fan coils, a compliance date of 3-5 years is more realistic. Once the proposed regulation takes effect, Trane air handling equipment will need to revise its product offering, update selection codes, test and certify revised equipment, and in some cases go through product redesign. A longer compliance period as would be expected should DOE establish energy conservation standards is more reasonable and will help avoid the interruption of other Trane product update initiatives.

Ingersoll Rand takes seriously the targets laid out in our Climate Commitment, including a reduction in the GHG footprint of our products of 50 percent by 2020. A core part of our business strategy is to provide our customers with solutions to help lessen their contribution to climate change, and to that end we strongly support reasonable energy efficiency regulations on our products. One of our biggest concerns with the CEC Draft Staff report is that, for products already optimized for energy efficiency, the proposed regulations will create a barrier, rather than accelerate, a transition to next-generation, climate-friendly equipment. It is our hope that CEC recognizes the opportunities presented by the alternatives to fan component regulation in order to meet its goals. Ingersoll Rand recognizes the role we can play in helping California meet its target for a 40 percent reduction in GHG emissions by 2030 as set forth in SB 32 and a doubling of building efficiency, as well as the potential 40 percent reduction in building sector emissions by 2030 that AB 3232 has directed CEC to assess. We look forward to continuing our work with the state in order to do so.

We appreciate the opportunity to provide comments on the CEC Draft Staff Report, Analysis of Efficiency Standards and Test Procedures for Commercial and Industrial Fans and Blowers. If you wish to discuss these comments any further, please do not hesitate to contact me.

Sincerely,

Mark Lessans
Energy Efficiency Analyst