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AHRI Comments â€“ Title 20 Pre-Rulemaking â€“ June 2018 Draft Staff Report â€“ Commercial and Industrial Fans & Blowers

See attached document

Additional submitted attachment is included below.

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September 28, 2018

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

Re: AHRI Comments – Title 20 Pre-Rulemaking – June 2018 Draft Staff Report – Commercial and Industrial Fans & Blowers *[Docket No. 17-AAER-06]*

Dear CEC Staff:

The attached comments are submitted in response to the California Energy Commission (CEC) Pre-Rulemaking June 2018 Draft Staff Report[1] issued on June 11, 2018, and meeting held on July 11, regarding minimum efficiency standards for commercial and industrial fans into California's Appliance Efficiency Standards in Title 20 of the California Code of Regulations, Sections 1601 through 1609.

AHRI is the trade association representing manufacturers of heating, cooling, water heating, and 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 and water heating industry is worth more than $44 billion. In the United States alone, the HVACR and water heating industry supports 1.3 million jobs and $256 billion in economic activity annually. In addition to its activities as a global standards developer, AHRI works closely with other global codes and standards developers as well as utilities to ensure their access to the latest technology and innovation from the HVACR and water heating industry.

AHRI proposes that the CEC limit the scope of the proposed regulation on commercial and industrial fans and blowers (CIFB) to stand-alone fans only and exclude from the scope all fans embedded in residential, commercial, and industrial HVACR and water heating equipment (embedded fans) from any fan standards. Embedded fan standards would save minimal if any energy, would create needless testing and other requirements, and would raise costs for consumers. Virtually all the potential energy savings from

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[1] Galdámez, Alejandro. 2017. *Analysis of Efficiency Standards and Test Procedures for Commercial and Industrial Fans and Blowers. California Energy Commission*. Publication Number: CEC-400-2018-014-SD.

embedded fans are already covered by other Federal and California standards. California is explicitly prevented from establishing standards on federally regulated product.

Federal energy conservation standards generally preempt state laws or regulation concerning energy conservation testing, labeling, and standards. Through the Energy Policy and Conservation Act of 1975 (EPCA), Congress has granted authority to the Department of Energy (DOE) to establish federal appliance and equipment standards. In addition, DOE implements minimum efficiency standards for a wide range of appliances and equipment used in commercial and residential buildings. The commercial and industrial fans and blowers embedded in the HVACR and water heating equipment are covered by EPCA and thus subject to the energy efficiency standards established by EPCA. Any potential energy efficiency savings that would result from the proposed efficiency savings for commercial and industrials fans and blowers embedded in other federally regulated equipment are covered by EPCA.

Any state regulation that purports to impose energy efficiency minimums on the components of regulated products inhibits innovation, are contrary to EPCA's double-regulation prohibition, and are expressly preempted by federal law. California may regulate fans and blowers, but not the components of federally regulated products. However, as explained in these comments, implementing an application-specific regulation as an appliance efficiency regulation is a mistake. Regulation of stand-alone fans using the fan efficiency index (FEI) metric is appropriate and enforceable – in a building standard – in Title 24.

Corrections to the U.S. Department of Energy's (DOE) analysis, used as the underlying analysis for California, show that additional standards on embedded fans do not meet Energy Commission criteria for significant statewide energy savings or for cost-effectiveness to consumers.

The CEC is Expressly Preempted by the Federal Government from Regulating Embedded Commercial and Industrial Fans

"'Embedded fan' means a fan that is set or fixed firmly inside or attached to a surrounding piece of equipment whose purpose exceeds that of a fan or is different than that of a stand-alone fan. *This equipment may have safety or energy efficiency requirements of its own.* Examples of embedded fans include supply fans in air-handling units, condenser fans in heat rejection equipment, tangential blowers in air curtain units, and induced or forced draft combustion blowers in boilers or furnaces."[2]

[2] Staff Report at 60-61.

Despite CEC's assertions to the contrary,[3] CEC's Staff Proposal includes fans that are embedded in equipment that are already regulated by the Department of Energy.[4] Such fans include transport refrigeration fans, small commercial split system air-conditioning and heating equipment with cooling capacity less than 65,000 Btu/h, hydronic heating and burner fans, and refrigeration systems.[5] For the reasons stated below, CEC is expressly preempted from regulating these embedded fans under EPCA's preemption provision.

CEC is expressly preempted from setting energy efficiency standards for products that DOE regulates.[6] Under EPCA's preemption provision, state regulations "concerning" the "energy efficiency" or "energy use" of covered commercial and industrial equipment are no longer effective when a Federal standard becomes effective for those covered equipment.[7] Courts have interpreted this preemption provision to be expansive, finding that the term "concerning" suggests Congress intended the provision to have a "broad preemptive purpose."[8]

In enacting EPCA, Congress noted that preemption applies to an "entire product type as listed in the coverage section" of EPCA.[9] In effect, Congress intended that 42 U.S.C. § 6297 would "preempt State law under most circumstances."[10] The limited exceptions Congress provided were intended to account for unique State-specific interests, such as state building codes.[11] And even with those exceptions, Congress was deliberate that states could not set back-door energy efficiency standards through building codes that would "expressly or effectively require the installation of covered products whose efficiencies exceed . . . the applicable Federal standard."[12]

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[3] *See* California Energy Commission Docket No. 17-AAER-06, Document No. 224115, California Energy Commission Presentation - Commercial and Industrial Fans and Blowers at 5 (Jul. 10, 2018), https://efiling.energy.ca.gov/GetDocument.aspx?tn=224115 ("Staff proposal focuses on . . . embedded fans in *non-regulated equipment*") (emphasis added).

[4] *See* California Energy Commission Docket No. 17-AAER-06, Document No. 224132, AHRI Presentation to California Energy Commission at 4 (July 11, 2018), *available at* https://efiling.energy.ca.gov/GetDocument.aspx?tn=224132.

[5] *Id.*

[6] *Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque*, No. 08-633, 2008 WL 5586316, No. 08-633 at *6 (D. N.M. Oct. 3, 2008); *Nat'l Elec. Mfrs. Ass'n v. Calif. Energy Comm'n*, No. 2:17-CV-01625-KJM-AC, 2017 WL 6558134 at *5 (E.D. Ca. Dec. 21, 2017).

[7] *See* 42 U.S.C. § 6297(c) (2016). Note that the statutory "crosswalk" at 42 U.S.C. § 6316(a)(10) that applies to covered equipment described in § 6311(1)(L), including commercial fans and blowers, incorporates § 6297(c).

[8] *See id.*; *see also Metro. Life Ins. Co. v. Massachusetts*, 471 U.S. 724, 739 (1985); *Nat'l Elec. Mfrs. Ass'n*, 2017 WL 6558134 at *5; but *see Air Conditioning & Refrigeration Inst. v. Energy Res. Conservation & Dev. Comm'n*, 410 F.3d 492 (9th Cir. 2005) (finding that the "legislative history of [EPCA] supports a narrow interpretation of the preemption provision" with respect to preempting state regulations requiring the submission of data to state government agencies.).

[9] H.R. Rep. No. 100–11, at 20 (1987). *See also* S. Rep. No. 93-526, at 46 (1973) (discussing "components" of a "climate-conditioning system").

[10] *Air Conditioning, Heating & Refrigeration Inst.*, 2008 WL 5586316, at *7 ("There is no doubt that Congress intended to preempt state regulation of the energy efficiency of certain building appliances in order to have uniform, express, national energy efficiency standards."); H.R. Rep. No. 100–11 at 19.

[11] H.R. Rep. No. 100–11 at 19.

[12] *Id.* at 26

Two recent cases have affirmed Congress's intent. In Air Conditioning, Heating & Refrigeration Institute v. City of Albuquerque, the district court held that an Albuquerque building code requiring new buildings to have more efficient HVAC systems than required by the minimum federal standard was preempted because the code was, in effect, raising the minimum federal standard.[13] Subsequently, in Building Industry Ass'n of Washington v. Washington State Building Code Council, the Ninth Circuit agreed with the New Mexico District Court's finding, distinguishing a Washington building code that provided alternatives to higher efficiency standards from the Albuquerque ordinance that created "legal compulsion to use higher efficiency products."[14]

Yet, in proposing minimum energy efficiency standards for embedded fans, CEC has proposed to do just that. Setting a minimum energy efficiency standard for embedded fans may "effectively require" higher energy efficiency of already-covered equipment such as small commercial split system air-conditioning and heating equipment and refrigeration systems.[15] Unlike standalone commercial and industrial fans and blowers where the CEC may properly issue standards until DOE issues a rule or coverage determination,[16] embedded fans directly affect the energy efficiency and energy use of certain covered commercial and residential equipment. Like building codes that effectively require the energy efficiency of a covered product to be higher without setting a minimum standard for that product, requiring greater efficiency from embedded fans in a covered product imparts a legal requirement for that already-covered product to be even more efficient.

In addition to the narrow building code preemption exception, other parts of EPCA reflect Congress's intent to limit component regulation from having an adverse effect on the efficiency of other products. For example, energy efficiency standards for small electric motors do not apply to "any small electric motor which is a component of" certain other covered products and equipment, such as residential air conditioners and heat pumps, clothes washers and dryers, and commercial-packaged air conditioning and heating equipment.[17] Similarly, in order to regulate "industrial equipment articles" that are component parts of consumer products, DOE must determine that "such articles are, to a significant extent, distributed in commerce other than as component parts for consumer products."[18]

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[13] 2008 WL 5586316, at *7. When the code was revised to include the strict prescriptive code provision and two performance-based alternatives, the court struck down the prescriptive code provision as an alternative, holding that any other conclusion would "defeat the purpose behind [the] broad preemption provision." *Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque*, 835 F. Supp. 2d 1133, 1137-38 (D. N.M. 2010).

[14] 683 F. 3d 1144, 1151-52 (9th Cir. 2012).

[15] *See* 10 C.F.R. § 431.92 (2018); 42 U.S.C. § 6311(1)(C

[16] Although commercial and industrial fans and blowers are not statutory "covered equipment," DOE may, "by rule," classify commercial and industrial fans and blowers as "covered equipment" if DOE determines it is necessary to carry out the purposes of" EPCA. 42 U.S.C. §§ 6312(b), 6311(1)(L) & (2)(B)(ii)-(iii). In the past, DOE has issued a coverage determination for when electing to cover commercial and industrial products under 49 U.S.C. §§ 6311(2)(B) and 6312(b) and (c). *See, e.g.,* Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Final Determination of Compressors as Covered Equipment, 81 Fed. Reg. 79,991 (Nov. 15, 2016). As

[17] 42 U.S.C. § 6317(b)(3).

[18] *Id.* § 6312(c)(1) (emphasis added).

In general, DOE regulates products as a whole and not by component. Although DOE has previously regulated furnace fans[19] and electric motors,[20] DOE did so under unique authority provided in the sections of EPCA specific to those products and equipment. In fact, under the general industrial component requirement to show that embedded fans are distributed in commerce other than as component parts in a consumer product, regulation of embedded fans could arguably fall short of even DOE's regulatory authority, as far as the fans are embedded in consumer products. Given DOE's limited authority to regulate component parts of covered products and equipment, it is unlikely that Congress intended states to have greater component regulatory authority than the Federal government.[21]

Finally, although courts have not interpreted EPCA's preemption provision in the context of component regulation, preemption jurisprudence in other administrative areas supports AHRI's position. Under a similar federal preemption provision in the Food, Drug, and Cosmetic Act, courts have found that Food and Drug Administration (FDA) approval of a medical device covers approval of all its components, preempting any component-based state law.[22] Similarly, the Department of Agriculture's preemption authority under the Plant Pest Act preempts state laws that ban plants created from a federally regulated plant pest.[23] In other words, federal courts tend to read broad preemption statutes like EPCA as categorically preempting state regulations that could otherwise affect the federally-regulated item.

Under this reading, even if the CEC's proposed embedded fan regulations would not lower the overall energy usage of a covered product, the CEC would still be preempted because the fan regulation would still affect the energy usage of the federally regulated product.[24] EPCA's preemption provision does not preclude only energy efficiency

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[19] DOE is required by EPCA to consider and prescribe new energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work. *Id.* § 6295(f)(4)(D).

[20] *Id.* § 6313(b)(1) (covering electric motors "alone or as a component of another piece of equipment").

[21] While CEC's proposed regulatory language in the Staff Report excluded most embedded fans in covered residential products, the list may not be exhaustive. *See* Staff Report at 58-59.

[22] *See* 21 U.S.C. § 360k(a)(1) ("No State or political subdivision of a State may establish or continue in effect with respect to a device intended for human use any requirement. . . which is different from, or in addition to, any requirement applicable under this chapter to the device."); *Hawkins v. Medtronic, Inc.*, No. 13-cv-0499, 2014 WL 346622, at *5 (E.D. Cal. Jan. 30, 2014) ("The requirements set forth in the premarket approval for the entire device are just as applicable to the components that together form the FDA approved device as the device itself."); *Riley v. Cordis Corp*., 625 F.Supp.2d 769, 780 (D. Minn. 2009) ("It makes no sense—indeed, it would probably be impossible—to pick apart the components of a medical device and apply different preemption analyses to different components.").

[23] "No State or political subdivision of a State may regulate the movement in interstate commerce of any ... plant, ... plant pest, noxious weed, or plant product . . . if the Secretary has issued a regulation or order to prevent the dissemination of the . . . plant pest, or noxious weed within the United States." 7 U.S.C. § 7756(b)(1). *See Atay v. Cty. of Maui*, 842 F.3d 688, 702 (9th Cir. 2016) ("What matters under the preemption clause . . . is whether a local law seeks to control, eradicate, or prevent the introduction or dissemination of plants that APHIS regulates as plant pests. APHIS deems nearly all GE plants to be plant pests because nearly all GE plants are created using Agrobacterium, which is a listed plant pest.").

[24] This could also be a case for conflict preemption. To demonstrate implied conflict preemption, a party must show that it is impossible to comply with both federal and state requirements or that the state law stands as an obstacle to

standards that are more stringent—it also preempts state regulation "concerning" energy use or energy efficiency.[25]

Congress enacted the preemption provision of EPCA to eliminate the systems of separate state appliance standards that created a "growing patchwork of differing state regulations."[26] By attempting to regulate fans embedded in products and equipment already regulated by the Federal government, CEC would add a new layer of complexity to the regulatory "patchwork." Therefore, to align with the plain language of EPCA's preemption provision, and Congress' clear intent on its broad effect, CEC must eliminate certain embedded fans from its proposed regulatory language.

The CEC is Expressly Preempted by the California Government from Regulating Embedded Commercial and Industrial Fans and Mobile Equipment

California explicitly recognizes federal preemption, even of components, within its own code when it states, "If an appliance can serve more than one function," and "…if the primary function is served by a federally-regulated appliance, the primary function appliance shall meet the applicable standard in Section 1605.1 (Federal and State Standards for Federally-Regulated Appliances)…"[27] Within the definition of embedded fans in the draft staff report, CEC staff acknowledges that fans are secondary components. While specific allowances are made for state-regulated equipment,[28] no similar permissions are given to regulate secondary functions of federally regulated products. Indeed, the primary function of all regulated equipment is expressed within the product's metric. This exclusion is broad and would apply regardless of whether any specific component's energy consumption is accounted for within the metric. CEC must eliminate all embedded fans in federally regulated products from its proposed regulatory language.

Title 20 Section § 1601 explicitly excludes products, "designed and sold exclusively for use in recreational vehicles, or other mobile equipment" from the scope of the regulation. CEC cannot regulate fans embedded in mobile refrigeration equipment, even if grid-connectable.

Replacement Fans Must be Excluded

HVACR and water heating equipment is built, tested and certified as a completed design, which is reliant upon a specific set of components. Changing these components changes the performance of the equipment. In many cases, such as supply air fans with air flow through gas fired heat exchangers, hot water coils or electric resistance units, there are a variety of safety standards affected by air flow in addition to the performance standards.

Congress's objectives. *Whistler Invs., Inc. v. Depository Tr. & Clearing Corp.*, 539 F.3d 1159, 1164 (9th Cir. 2008).

[25] 49 U.S.C. § 6297(c).

[26] S. Rep. No. 100-6, at 4 (1987).

[27] California Title 20 § 1605(f).

[28] *Id.*

The testing all legacy equipment because of a fan change will be cost and resource prohibitive. If a replacement fan is not compliant then, in most cases, an unsafe, engineered-to-fit substitution would be required. Costs, risks, and time required to retest the HVACR and water heating equipment would all be prohibitive. Testing could be impractical if the HVACR and water heating equipment is out of production. Manufacturers would be forced to rebuild an out-of-production unit solely for the purpose of testing the new fan. There may be instances where such part substitution makes sense, but that is not a reasonable basis for a broad, minimum standard.

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 becomes inoperable. If an exact replacement is not permitted, 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 shown in NODA3. 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 cannot be confirmed as safe without extensive testing.

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 CEC 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 driven 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 in an emergency, 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. Furthermore, since every fan is both compliant or non-compliant based on design conditions that are only verifiable in building design documents, exemptions do not complicate enforcement.

Mandating alternative Panel Fans as spare parts in repairs would be impractical. It is possible to substitute a new condenser fan into an existing air-cooled chiller but that does not necessarily yield any gain in chiller efficiency. Changing the fan may result in a different balance point for the fan/motor. As such it may actually increase the energy consumption because the condenser system is based upon heat exchanger size, heat exchanger pressure drop, system pressure drop and fan energy consumption. A

replacement fan with a different efficiency profile may be less efficient at a certain static pressure than the existing design fan. A simple replacement with a fan with higher peak efficiency may not have a higher efficiency at its actual operating point. In addition, there may be size and other constraints on the use of alternative condenser fans.

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 and Title 24. 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 CEC 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 CEC does not exclude these fans, then the analysis energy savings must be adjusted accordingly.

AHRI recommends that California not set standards for fan blades, impellers, wheels and other components used to repair/replace fans in existing HVACR and water heating equipment (Replacement Embedded Fans). AHRI has no comment on or any position regarding standards for stand-alone fans or fans not embedded in HVACR equipment (except for fan components excluded above).

A Sensible Approach to Regulating Stand-Alone Fans is Possible – Through Title 24

All states are obligated to keep up with ASHRAE Standard 90.1 — Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1 or Standard 90.1 or 90.1)[29]. Whenever ASHRAE 90.1 is updated, the DOE determines if the new version would achieve greater energy efficiency in buildings subject to the code. Within two years of an affirmative determination, states are required to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, update their codes to meet or exceed the updated edition of Standard 90.1. California is the leader in this effort. DOE issued the determination on ANSI/ASHRAE/IES Standard 90.1-2016 — Energy Standard for Buildings Except Low-Rise Residential Buildings (ASHRAE 90.1-2016) in February 2018. California adopted revisions to Title 24 in May of this year.

[29] 42 U.S.C. 6833

A proposal to include the fan energy index as the new metric for fan efficiency is currently under review by the ASHRAE 90.1 Standing Standards Project Committee (SSPC 90.1).[30] The first public review period closed July 29, 2018. While comments were received, there were no votes opposing the release of the public review of the addendum in the committee. The SSPC will consider comments received at the October meeting. Inclusion of fan regulation through the adoption of Addendum "ao" and the FEI metric in the 2019 edition of Standard 90.1 seems inevitable.

In California, the Statewide Utility Codes and Standards Program actively supports code-setting bodies in developing and revising codes and standards through Codes and Standards Enhancement (CASE) initiatives. The Program's intent is to achieve significant energy savings through the development of reasonable, responsible, and cost-effective code changes. For Title 24-2019, the Statewide CASE Team reviewed and made recommendations to adopt seven requirements included in ASHRAE 90.1-2016 into Title 24, Part 6. In the draft staff report, CEC states that Section140.4(c) of Title 24 are only applicable to new buildings and not every installation; however, that is incorrect. Section 141.0 on additions, alterations, and repairs also requires newly installed HVAC systems in existing buildings to comply with Section 140.4(c) if the prescriptive path is chosen. AHRI is confident that the Statewide CASE Team review will continue to be diligent in its review of ASHRAE 90.1 and that a proposal will be made to include fan regulation through the FEI metric after the 2019 edition of 90.1 is published.

AHRI is concerned that any application-specific regulation cannot be achieved by a Title 20 standard. AMCA 208 states the purpose of FEI is to provide, "a standardized and consistent basis to compare fan energy performance across fan types and sizes *at a given fan duty point*." By virtue of the selection-based nature of the metric, a comparison of products would not be reasonably possible with the proposed listing of the appliance in the database.[31] Even for stand-alone fans, this listing proposal would not allow for comparison of products as it only lists discrete points, not duty points, across different performance ranges. Virtually all fans are compliant within a given duty range for a fan. How will this be enforced?

Discrete listing of points, based on performance of the product, would be different for each product. Each fan has its own range of performance. The performance range of one type of fan would not be the same for a fan of a different size or different type. If the ranges are different, how would a consumer, even a licensed engineer, reasonably compare discrete options in the California directory and use this information to enable selection of more efficient products? Consumers cannot interpolate FEIs in a listing directory. It would be reasonable to compare the FEIs of two products which were selected for the same application, at the same airflow, fan speed and max shaft input power, using a selection software program or manufacturer's catalog.

[30] Proposed Addendum ao to Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings. First Public Review Draft (June 2018)
[31] Title 20 Section § 1606

The database proposed for regulation under Title 20 would not allow customers to compare products where the embedded fan could be tested alone and those that could not. This is due to limitations in the test procedure, Air Movement and Control Association (AMCA) Standard 208-18 Calculation of the Fan Energy Index (FEI). Indeed, the standard does not apply to fan performance when fans are embedded inside of other equipment.[32] Informative Annex D gives guidance on the conversion of standalone fan performance to that of an embedded fan, but it is not mandatory and more importantly would require a final product test standard for selection, comparison and enforcement. If a final product test standard exists, then use the final test standard to rate the products. AHRI's July 11, 2018, presentation highlights an example of the "FEI paradox." While, the standard can be used to calculate FEI for a fan that, when tested in a stand-alone configuration and will be embedded into other equipment, it does not account for embedded fans that do not have fans that can be tested in a stand-alone configuration. Comparison of products is a fundamental purpose of any energy conservation standard. Without being able to compare like products, consumers are not able to make informed purchasing decisions.

It is unclear how customers would be able to purchase equipment that cannot be tested in accordance with the test procedure as is currently drafted. Draft regulatory language in the staff report and Title 20 Section1603(a) only provides for exceptions to the testing requirements for appliances for which there is a waiver of the federal test method. Embedded fans that cannot be removed for testing, even if they are federally-regulated, would not be able to be listed in the database. Could these products still be sold in California in the current proposal? CEC cannot impose regulations which prevent federally-regulated products with embedded fans from being sold and should not impose regulations that prohibits products that are outside the scope of the test procedure.

Implementing FEI in Title 24, with the exceptions agreed to by all stakeholders including advocates, industry, and users of the 90.1 proposal, would be more likely to produce an energy-saving, enforceable, sensible approach to fan regulation. It will also capture the majority of potential fan energy savings while minimizing the compliance burden on manufacturers, suppliers, system designers, consumers, and state resources.

Efficiency Standard too High and Implementation Date too Soon

It has been proposed that fans sold in California and manufactured on or after January 1, 2020, will need to have a minimum FEI of 1.00. This is based on EL3 in DOE NODA3. AHRI disagrees with CEC's belief that HVACR and water heating manufacturers will be able to offer fans that are compliant with any energy conservation standards CEC may set prior to the five-year compliance timeline. OEMs will be 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

[32] Section 4.4 of AMCA 208-2018

those products. AHRI requests that to the extent that the CIFB regulation will affect the availability of fans on the market for HVACR and water heating OEMs, that a phase-in of the regulation is adopted. Once the regulation takes effect, fan suppliers and OEMs will have concurrent compliance timelines. Component fans that were once available for a product's full operating range, 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 required for this equipment assessment will not be available until after fan manufacturers are actually complying with the rule. Additional conversion costs are often required after the fan and cabinet have been redesigned and this 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 following internal component swaps or cabinet redesigns and is required before products can be sold. Also, testing must be conducted for heating equipment, electric heat, safety, refrigerant, and sound when components or cabinets are redesigned. In NODA3, DOE has assumed that the equipment cabinet size would not change if the fan changes diameter by two-inches and corresponding housing change of four 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 housing increase of four-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 in Table 1, below:

Table 1: Cost Impact of Changing an Embedded Fan

	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.

Modifications Required for CEC's Analysis

NODA3 was not the analysis of a completed regulation. In NODA3, DOE sought answers and more specific data to make the analysis applicable to embedded fans. As the federal regulation is still in process, revisions have not been published to address specific concern.

Several well-documented incorrect assumptions have been noted to DOE and CEC staff[33] regarding the NODA3 analyses of embedded fans. Relevant government reports cited have been attached to these comments. 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 generally not certified products. As this data are not per the DOE-working group 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 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.

Also, CEC does not account for the impact of Title 24, which is significantly more stringent than national average building code, in its analysis. The cumulative impact of these errors leads to significant overestimation of energy saving potential cost-savings for California consumers of embedded fans.

Panel Fans

DOE projected that the potential national savings from Panel Fans, including both air-cooled chillers and standalone panel fans, was 1.33 quads over 30 years. However, DOE made somewhat offsetting errors in its inputs on air-cooled chillers and used the incorrect energy savings from the LCC model to project the effects of a standard on OEM Panel Fans used in air-cooled chillers. Corrected for these errors, the total annual national energy savings available from OEM panel fans in air-cooled chillers are 0.08 quads (not including potential savings from approximately 100,000 annual shipments of non-embedded axial fans, applications unknown). The California portion

[33] Specific issues noted to CEC staff in AHRI's comments submitted to the Energy Commission as part of this rulemaking, in a presentation given to CEC staff on November 28, 2017, and reports cited in the comments were emailed to the staff report's author on November 29, 2017 by AHRI's consultant, Everett Shorey.

would be approximately 0.01 quad for the embedded air-cooled chiller panel fans over 30 years, again under the DOE assumptions.

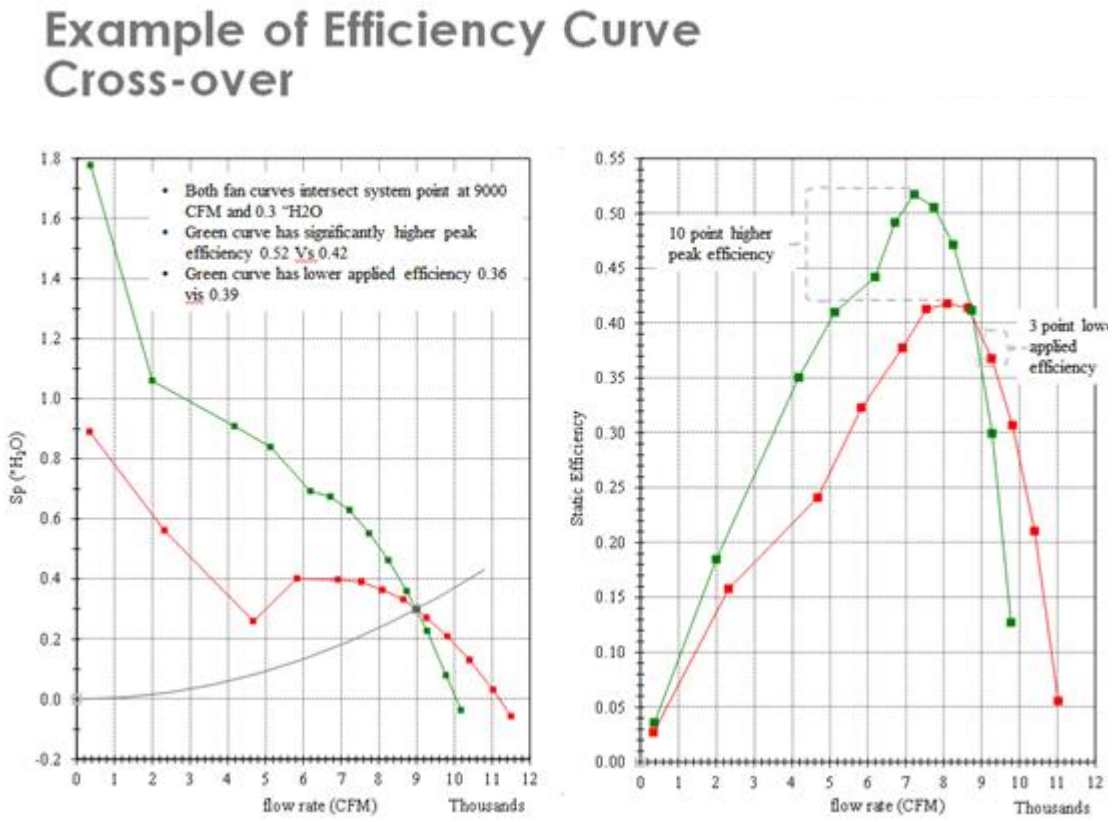
1. DOE assumed shipments of 12,759 air-cooled chillers. Based on data from the Current Industrial Reports (CIR), air-cooled chiller shipments averaged 27,000 units from 1994 through 2010 (the last year the report was produced).[34] This is consistent with unpublished shipment data collected by AHRI from its members.
2. DOE assumed 14 panel fans per air-cooled chiller. This would be the equivalent of a 200-ton chiller. The weighted average shipments of air-cooled chillers is under 100 tons, and seven panel fans per chiller is a more reasonable estimate.
3. Implicit annual energy consumption per OEM panel fan in the LCC model is 2,504 to 2,260 kWh/year (from EL0 to EL6), not the 11,563 to 4,002 kWh/year in the NIA, with the LCC consumption transferred to the NIA.
4. California portion assumed at 12-percent of national sales.

However, DOE's assumptions do not account for virtually all air-cooled chillers are sold as integrated units containing both the compressor and the condensing unit.[35] These chillers packages are subject to ASHRAE 90.1 EER and IPLV energy consumption limits, which are included in the equipment portion of California Title 24, Section 110.2-D. Integrated units are optimized to meet the ASHRAE 90.1 standard and any requirement placed on a single component will cause re-optimization (almost always at a higher cost) around a different configuration of compressor, coil, fans, etc. The energy efficiency standards are equipment, not application based (akin to Title 20 standards) and, thus, cover equipment used in both new construction, renovations and as replacements for equipment in existing buildings.

A "more efficient" fan may not yield a more efficient unit if the fan curve performance does not meet the likely operating conditions. In a specific example, there may be a "higher efficiency" fan that does not work as well as the lower efficiency fan in a specific condenser fan application because of where the fan actually operates. In the below figure, the red fan offers better performance relative to the green fan, even though the green fan has a peak efficiency well above the red one. The fan operates based on flowrate and static pressure and, in this case, the red fan is the better fan. This specific example indicates that the designer needs to be extremely careful in applying embedded fans into a product (Figure 1).

[34] US Census Bureau, Current Industrial Reports, MA35M/MA333M, Refrigeration, Air Conditioning and Warm Air Equipment
[35] AHRI survey of members, unpublished

Figure 1: Condenser Fan Operating Characteristics



Source: Courtesy of Ingersoll Rand

For all of the reasons stated above, the energy savings from a fan component standard on embedded panel fans in air-cooled chillers is likely to be very close to zero both for individual building owners and for California in total.

The economic effects on end consumers of a Panel Fan standard for embedded condenser fans in air-cooled chillers will be an increased per fan cost of $173 (or 10% increase over current price) to the end customer with no expected energy savings and, therefore, no operating cost reduction.[36]

Central Station Air-handling Units and Related Air Distribution Equipment

DOE estimated that the 30-year national energy savings from supply and exhaust/return air applications in commercial air conditioning equipment not already covered by Title 20 would be 0.76 quads for unhoused centrifugal fans and 1.59 quads for housed centrifugal fans. Central station air-handling units make up virtually all the projected savings in unhoused centrifugal fans (Table 2). With the corrections to DOE's assumptions, detailed below, the actual national savings are likely to be less than 0.6 quads (Table 2) and 0.07 quads in California (Table 3).

[36] For LCC methodology, see Appendix B

Table 2: Projected National Potential Energy Savings

Type	Application	DOE (30-year Quads)	AHRI (30-year Quads)
Housed Centrifugal	Central Station Air-handling Units	0.67 quads	0.19 quads
	Unitary Exhaust and Return Air	0.92 quads	0.16 quads
	Total	1.59 quads	0.35 quads
Unhoused Centrifugal	Central Station Air-handling Units	0.76 quads	0.23 quads
	Grand Total	2.35 quads	0.58 quads

Source: DOE cif_noda_3nia.xlsm, AHRI from revisions per Appendix A

Table 2, above, shows the maximum potential national energy savings projected by DOE and does not include any of the effects from market forces or from the fan power limits in Title 24, Section 140.4(c). In the draft staff report, CEC states that Section140.4(c) of Title 24 are only applicable to new buildings and not every installation; however, that is incorrect. Section 141.0 on additions, alterations, and repairs also requires newly installed HVAC systems in existing buildings to comply with Section 140.4(c) if the prescriptive path is chosen. The corresponding California potential savings are (Table 3):

Table 3: Projected California Potential Energy Savings

Type	Application	DOE (30-year Quads)	AHRI (30-year Quads)
Housed Centrifugal	Central Station Air-handling Units	0.08 quads	0.02 quads
	Unitary Exhaust and Return Air	0.11 quads	0.02 quads
	Total	0.19 quads	0.04 quads
Unhoused Centrifugal	Central Station Air-handling Units	0.09 quads	0.03 quads
	Grand Total	0.28 quads	0.07 quads

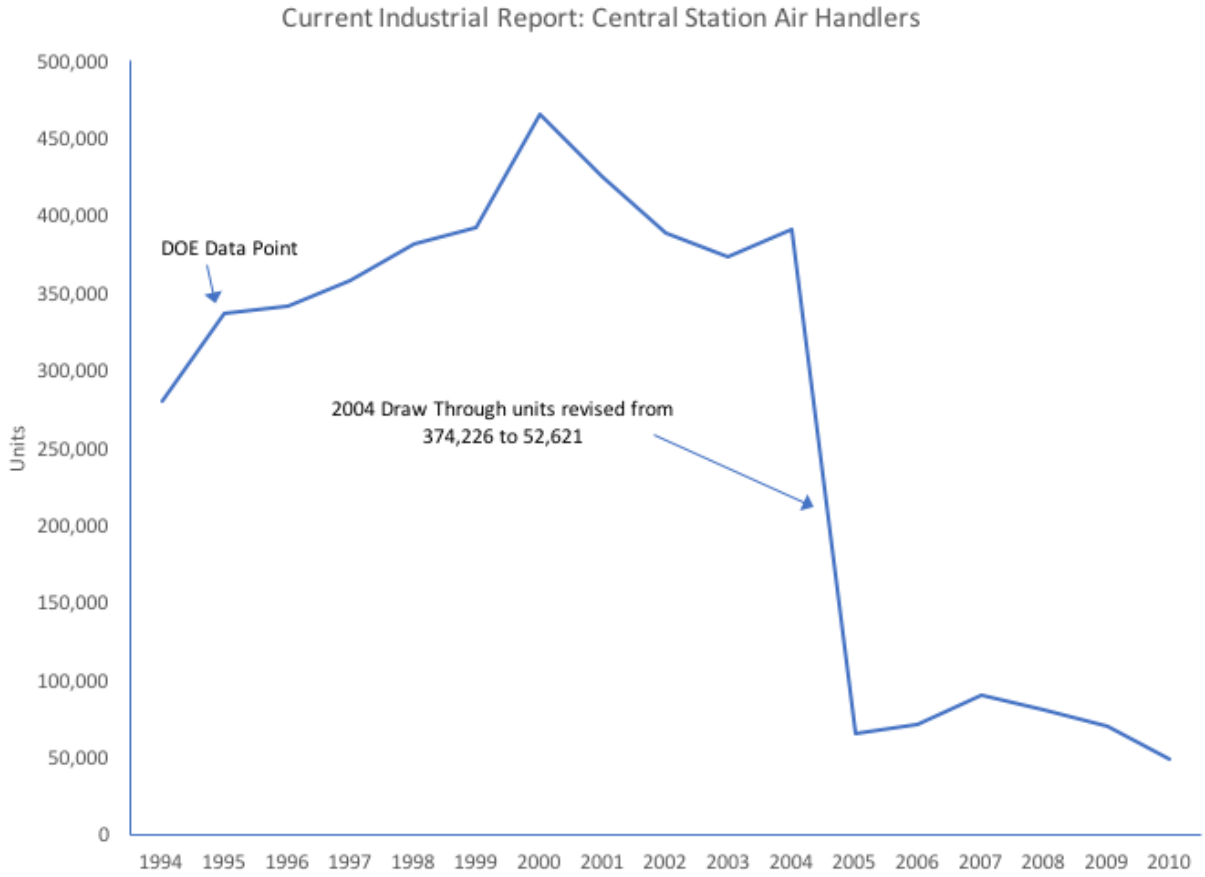
Source: DOE cif_noda_3nia.xlsm, AHRI from revisions per Appendix A

The major reason for the dramatic drop in savings from central station air-handling units is that DOE used old, incorrect data to project the number of central station air-handling units shipped. DOE included in its analysis an estimate that there are 330,402 central station air-handling units shipped.[37] This is based on an Arthur D. Little study (Opportunities for Energy Savings in the Residential and Commercial Sectors with High-Efficiency Electric Motors. December 1999. Prepared for the US

[37] US Department of Energy, Docket EERE-2013-BT-STD-0006-0192, cif-Noda_3_nia.xlsm, cell H44

Department of Energy by Arthur D. Little, Inc.) which, in turn, relied on data from the US Department of Commerce, Census Bureau, Current Industrial Reports MA35M (CIR) for 1995. Arthur D. Little correctly used the data presented at that time in the CIR. However, there seems to have been a reporting error for product code 35851-13 central station air-handling units (motor driven fan type) – draw through, reported as 315,723 units in 1995, the year referenced by Arthur D. Little. This product category was revised for 2004 and subsequent years in the CIR for 2005, with 2004 shipments for that product code (now 3334151117) reduced from 374,226 to 52,621. The shipments for total central station air-handling units remained in the range of 48,000 to 90,000 units until 2015, when the CIRs were discontinued (Figure 2). AHRI collects but does not make public shipment data for central station air-handling units and the AHRI data is consistent with shipments in the high tens of thousands of units per year.

Figure 2: Reported US Shipments of Central Station Air-handling Units



Source: US Department of Commerce, Census Bureau, Current Industrial Reports MA35M/MA333M

AHRI data shows a decline in central station air handling units from a peak in 2007 through 2016. Based on the declining trend in shipments and the average of shipments in the CIR from 2004 through 2015, a reasonable estimate of future central station air-handling unit shipments would be approximately 65,000 units per year, nationally.

The revised central station air-handling unit estimate of 0.58 quads nationally and 0.07 quads in California overstates the actual potential savings that would occur through a fan standard. Fans used in central station air-handling units are subject to the total fan power limitations of Title 24, Section 104.4 (c) for units used in new construction and renovation. These restrictions put substantial pressure on building designers to limit fan energy use and the effects of these limitations are not adequately captured in the Base Case efficiency assumptions in the DOE models, which are built around national averages where the full effect of the ASHRAE 90.1 standards (implicit in the Title 24 limitations) do not occur as other states do not update building standards as diligently as California.

More importantly, central station air-handling units are used in a building design and construction process that encourages the use of cost effective, higher efficiency solutions. A central station air-handling unit is part of a total (applied) system made up of multiple components (chiller, air handler, air distribution boxes, piping, pumps, ducting, controls) that need to be specified individually and sized to meet the requirements of a specific building. As a practical matter, this design process requires the skills and expertise of professional engineers. Moreover, the California Title 24 Design Review requirement includes the requirement for participation by a professional engineer. Therefore, the expertise to review and optimize fan and other mechanical systems is required in all new nonresidential construction and renovations in California.

DOE forecasts that centrifugal housed and unhoused fans have favorable economics at a Standards Efficiency Level 5 (EL5) (Table 4):

Table 4: DOE LCC Estimate - Centrifugal Fans – EL5

	LCC Savings	Payback Period	% With Net Cost
Housed Centrifugal	$310	5 years	22.3%
Unhoused Centrifugal	$280	3 years	5.0%

Source: DOE cif_noda_3.xlsm

While this is the only data available on fan economics, it is not germane to the question of a standard on embedded fans in California:

- Considers all fans, not OEM fans,
- Uses an incorrect methodology to estimate per fan costs of engineering, testing and other redesign costs and investments,
- Uses national, rather than California electricity costs, and
- Does not include amortization of re-design costs.

Correcting for these factors yields an increase in first costs of 12-percent for unhoused and 68-percent for housed centrifugal fans and negative LCC savings, even at a proxy for California TDV electricity rates (Table 5). There are almost certainly additional

mistakes in the allocation of fans by fan type in the NIA and LCC analyses, yielding the significant difference between housed and unhoused centrifugal fan economics. There are no obvious technical or application issues that would lead to these differences. This highlights the complexity and lack of transparency in the DOE analysis. In any event, even before considering the many additional errors in assumptions commented on by AHRI and others in the DOE analysis relating to testing, certification and costs from accommodating proposed larger fan wheels and on the real effects of market forces and Title 24 fan horsepower limits, there is no likely consumer benefit from a component fan standard for embedded fans in central station air-handling units. For example, central station air handling units are tested in-accordance with AHRI 430. To require the fans to be additionally tested in-accordance with AMCA 210 adds costs to a customer. There are also costs associated with dynamic, safety, and seismic testing.

Table 5: AHRI Corrected LCC Estimate - Centrifugal Fans

	Increased Consumer First Cost	LCC Savings – Average California	LCC Savings – 20% TDV Proxy
Housed Centrifugal	68%	($576)	($473)
Unhoused Centrifugal	12%	($92)	($8)

Source: DOE cif_noda_3.xlsm corrected by AHRI as per Appendix B

In summary, the Title 24 fan horsepower limitations, the California design review process and market forces result in the use of efficient fans for central station air-handling units. Additional component performance standards will not be cost effective to consumers in general and will mostly target buildings where there is good reason not to use a more efficient fan. The actual energy savings potential is low and the disadvantages to building owners are high.

Commercial Unitary Air-conditioners and Heat Pumps

While AHRI disputes CEC's legal authority to regulated fans embedded into federally-regulated products, CEC should also understand that DOE's analysis contained errors relating to this equipment. Commercial unitary equipment falls into two distinct segments: light and heavy commercial. Light commercial systems are generally lower capacity, are used in less complex applications and have or are specified with fewer options. Heavy commercial unitary systems can approach the complexity of applied, chiller systems and are offered with a wider variety of options. In practice, exhaust/return air fans and economizers are commonplace in heavy commercial and are rare in light commercial equipment.

DOE estimated, in its supporting documents to the ASRAC Working Group, that improving the energy efficiency of exhaust/return air fan systems in rooftop air-conditioners could result in 0.92 quads of energy saved on a national basis.[38] This

[38] US Department of Energy, Docket EERE-2013-BT-STD-0006-0192, cif-Noda_3-nia.xlsm. See Methodology Appendix A

would translate into 0.11 quads of energy saved in California.[39] However, DOE has not accurately reflected the segmentation between light and heavy commercial equipment and has, thus, overestimated the portion of rooftop air-conditioners with exhaust/return air fans. AHRI has surveyed its members on the percentage of commercial rooftop air-conditioners and heat pumps with exhaust/return air fan systems and reports the percentage of rooftop units with exhaust/return air fans (Table 6):

Table 6: Shipments of Rooftop Units with Exhaust or Return Air Fans

		DOE	AHRI
>=65,000 Btu/h and <135,000 Btu/h	Return	50%	5 to 7%
	Exhaust	0%	
>=135,000 Btu/h and <240,000 Btu/h	Return	50%	7 to 10%
	Exhaust	0%	
>=240,000 Btu/h and <760,000 Btu/h	Return	50%	60 to 75%
	Exhaust	100%	
>=760,000 Btu/h	Return/Exhaust	NA	80 to 90%

Source: AHRI Survey of Manufacturers

Correcting for the proper exhaust/return air fan percentages yields a national 30-year energy savings of 0.16 quads and 0.019 quads in California, with these savings almost exclusively coming from heavy commercial rooftops. The possible energy savings of 0.019 quads is split approximately evenly between units in new construction and replacement units.

As with central station air-handling units, new construction in California is subject to the Section 104.4 (c) fan energy limits as well as the design review processes of Title 24. Heavy commercial rooftop units, also like central station air-handling units, are typically used in more complex buildings with professional engineers involved in the design process. This segment is already adopting more advanced energy savings systems. For example, over 70% of the supply fans in heavy commercial rooftops have variable speed drives, a more expensive and more efficient option. Market forces, other incentives and the fan horsepower requirements are already leading to the use of efficient equipment where it is cost effective. Therefore, the available energy savings that also show consumer benefits are almost certainly less than forecast even by the revised DOE estimates. The 0.009 quads of savings forecast in new construction is likely to be considerably less in practice.

The ease of moving to a different exhaust/return air fan configuration depends upon the overall design for the rooftop unit. For fans inside the basic structural unit, increasing the size of a centrifugal fan wheel would require a redesign and an increase

[39] Based on 12% conversion from US to California, see Methodology Appendix

in the size of the fan section of the rooftop unit and, often, of the rooftop unit as a whole. This would add to costs, affect shipping and, in replacement applications, usually result in the added cost of a curb adapter. In addition, any change in the size, configuration or structure of the rooftop unit, or any other tested and certified product would entail retesting for seismic certification.

The user economic analysis for housed centrifugal fans described in Item 2. Central Station Air-handling Units (above) and in Table 5 includes the effects on exhaust/return air fans. It is not possible to disaggregate the DOE LCC analysis to distinguish between various types of housed centrifugal fans. The negative savings in LCC will also apply to exhaust/return air fans in rooftop air-conditioners.

Commercial Boilers and Water Heaters

Neither fans embedded in commercial boilers nor commercial waters were recommended by the DOE ASRAC WG to be excluded from the scope of the test procedure and energy conservations, even though the metric for commercial water heaters includes the embedded fan's energy. Commercial boilers, on the other hand, are examples of HVACR products with an embedded fan where the fan power is not covered by the product test procedures and efficiency standards. The actual energy savings potential from applying the proposed fan regulation to a boiler or water heater fan itself is likely to be de minimus and the total energy consumption may be increased due to effects on combustion. In addition, the complexity of integrating a new fan system into a boiler or water heater is considerable, raising costs, ultimately passed on to consumers. The appropriate approach is to work through the commercial boiler's test standard's consensus process and find a path to incorporate the electrical energy used in a boiler system into the test procedure and the equipment ratings BSR/ASHRAE/AHRI Standard 155P, *Method of Testing for Rating Commercial Space Heating Boiler Systems* to include electrical power consumption from the fan is currently being drafted. The first public review of the standard closed on May 28, 2018. CEC must exclude fans embedded in commercial water heaters and boilers entirely from the California rulemaking.

Fans are used in commercial boilers and water heaters either to create forced draft for high efficiency gas-fired systems or to provide forced draft combustion air for oil or other systems with non-atmospheric burners. As such, the fan is an integral part of the combustion system. The burner and fan configuration affect the combustion efficiency, emissions and safety system of the boiler or water heater. A different fan cannot be introduced into the boiler or water heater without redesign, if there is a size or other physical change, and without significant retesting. This would make substitution of different fans completely impractical as replacement parts and raises the costs and complexity of switching from one fan to another.

The commercial boiler and water heater industries are small, with annual shipments of approximately 20,000 boiler units and under 2,000 hot water supply boilers[40] nationally per year, which limits both the total potential for energy savings and the

[40] DOE classification of "hot water supply boilers" includes commercial forced circulation instantaneous water heaters.

ability to recover any necessary redesign, testing and certification costs.[41] There is no estimate, at this time, of either the energy used by fans in commercial boilers and commercial water heaters or the potential for energy savings. The fans used in commercial storage water heaters are virtually all under one horsepower. Fans only exceed one horsepower in commercial boilers and hot water supply boilers with input rates exceeding two million Btu/h. For hot water supply boilers, according to the DOE estimates, approximately 12-percent of models exceed two million Btu/h, or approximately 250 boilers per year nationally.[42] The shipments for commercial boilers and hot water supply boilers are somewhat lower than those for air-cooled chillers; commercial boilers have only a single fan, while air-cooled chillers have multiple fans; and panel fans in air-cooled chillers are usually one to two horsepower or more. Therefore, the potential electrical energy savings from any redesign of commercial boiler fans are certainly less than those for air-cooled chillers, probably one-fifth or less since the average air-cooled chiller has seven fans and a boiler or water heater has only one. On that assumption, the potential 30-year electricity savings from commercial boiler fans would be on the order of 0.016 quads nationally and 0.0019 quads in California. There is also a potential that fan changes will result in increased standby losses and reduction in thermal efficiency that would result in a net energy loss.

Neither AHRI nor DOE nor CEC has estimated the potential effects on consumer economics. Given the small degree of energy savings and the small shipment volume relative to the significant redesign, testing and certification costs associated with incorporating a new fan, it is highly unlikely that there are significant positive consumer benefits.

Substitution Assumptions in DOE's Analysis

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. In virtually all cases, a two-percent selection window is required, and the 20-percent selection window would not satisfy the heating, cooling or ventilation needs for the application. 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 CEC insists on maintaining the DOE's 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.

[41] US Department of Energy, Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Commercial Packaged Boilers, March 4, 2016, Table 9A.2.2 for commercial boilers. EERE-2014-BT-STD-0042-0040, p.15, AHRI comments on Commercial Water Heaters correcting DOE shipment levels for hot water supply boilers.

[42] US Department of Energy, Technical Support Document: Energy Efficiency Program For Consumer Products and Commercial and Industrial Equipment: Commercial Water Heating Equipment, April 18, 2016, Figure 3.10.26, p.3-29

CEC's Life-Cycle Cost Does Not Account for Inability to Service Legacy Product
The life-cycle cost of complying with the standard should include the many consumers needing fan replacements for OEM products manufactured prior to the compliance date.

CEC Statewide Energy Savings – Forward Projections for Shipments Unsubstantiated
Tables A-4 and A-5 of the draft staff report lists shipments and sales information for stand-alone and embedded fans for US and in California – for 2019. The report was published in June 2018. Further, CEC does not state where the 2019 national numbers come from. NODA3 was published in 2015.

CEC Statewide Energy Savings – Peak Demand Reduction Overestimated
CEC did not explain how regulated products that are intended to be excluded from the scope of the regulation would reduce the number of embedded fans accounted for in the peak demand reduction and reduce anticipated energy savings.[43]

CEC is also grossly over estimated operating hours for embedded fans. It is unreasonable to assume average annual operating hours of 5,760 hours full speed operation. That is nearly 16 hours per day. In NODA3, DOE developed specific operating hours for embedded fans based on HVAC fan operating hours data which averaged 2,725 hours per year.[44] CEC should use no more than 2,725 operating hours in its analysis to estimate peak demand reduction.

Proposed Definitions

AHRI proposes that CEC adopt slightly modified definition for stand-alone fan discussed during the DOE ASRAC process[45]:

> Stand-alone fan: a rotary bladed machine used to convert electric power to air power with an energy output limited to 25 kJ/kg of air; typically consisting of an impeller, a shaft, bearings, a structure or housing, sold in a testable configuration, not intended for operation embedded in a piece of equipment, and, if included by the manufacturer at the time of sale, transmissions, driver and controls.

[43] Draft Staff Report, p. 48
[44] Arthur D. Little, Inc. "Opportunities for Energy Savings in the Residential and Commercial Sectors with High-Efficiency Electric Motors (Final Report)," (Dec. 1999); U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards for Water-Cooled and Evaporatively-Cooled Commercial Packaged AirConditioning and Heating Equipment. Final Rule Technical Support Document, Chapter 4 Energy Use Characterization (2012). Available at http://www.regulations.gov/document?D=EERE-2011-BT-STD-0029-0039; 19 U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. Energy Conservation Program for Certain Industrial Equipment: Energy Conservation Standards for Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment. NOPR Technical Support Document, Chapter 7 Energy Use Analysis (2014). Available at http://www.regulations.gov/document?D=EERE-2013-BT-STD-0007-0027.
[45] EERE-2013-BT-STD-0006-0074.xlsx

In addition, AHRI recommends the following definitions:

- Embedded Fan: A fan included as a component in residential, commercial, or industrial heating, ventilation, air-conditioning, refrigeration (HVACR) or water heating equipment where the fan is:
  - Permanently mounted in the equipment;
  - Used to support heat transfer, combustion, or other mechanisms within the equipment; and
  - Tested as part of equipment certification according to ANSI, ASHRAE, AHRI, DOE or other performance standards; and
  - Labeled for such use if sold as a fan assembly only for use within an exempt product.
- Replacement Embedded Fan:
  - An impeller, blade or wheel sold without a motor, with or without shaft and bearings, designed and marketed as a replacement for an existing part in an Embedded Fan application, including cross-reference(s) to the original fan part and a label stating that this part is for replacement purposes only.
  - Complete Embedded Fan assemblies including cross-reference(s) to the original blower part and a label stating that this part is for replacement purposes only.

Finally, the CEC has excluded fans used in heat rejection devices per the ASRAC Term Sheet, which AHRI fully supports. AHRI recommends that the specific definitions for excluded heat rejection equipment from the DOE Term Sheet be included in the Title 20 language.

Forward Curve Fans Warrant a Separate Product Class

Forward curved centrifugal housed fans (FC fans) require a separate equipment class for compact sizes compared to backward curved fans providing the same airflow and pressure as they provide *code-required* sound quality in low pressure and speed ranges. In comments to NODA3, AHRI expressed concerns that DOE 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, uncertified fan performance data. Unfortunately, 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. Additionally, the FEI metric is designed to remove no products from the marketplace but to rather restrict their operating range. As such all fans will have an area of compliance, even at EL5., the application ranges of FC fans by customers for low footprint, low static pressure and high airflows is 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. Indeed, in low static / high airflow applications, FC fans can be as or more efficient than a backward curved fan.

Another issue with using DOE's incomplete analysis as a final version is that DOE has not yet accounted for industry concerns regarding the necessity to preserve sound quality

as a performance-related features that justify differing standards. This issue must be addressed in CEC's analysis. This is important in a classroom learning setting where ambient sound levels affect learning outcomes and even more critical in English as Second Language settings.

Concern was also expressed in comments on the NODA3 that the Department has not properly accounted for the cost of forward curve fans in the analysis despite the first round of DOE 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 CEC engage in additional OEM interviews and appropriately use the information it receives to improve this analysis.

Enforcement Issues

There are several enforcement issues present in the proposed regulatory language. Some are exclusive to embedded fans, but some are applicable to all products under the scope of the proposed regulation. The DOE ASRAC Working Group intended the regulation to be implemented such that a certified fan bought from a manufacturer for inclusion in OEM equipment would not require retesting and recertification to DOE by the OEM if a VFD and/or drive is added. Unfortunately, Title 20 defines "Manufacturer" to mean "any person engaged in the original production or assembly of an appliance or any person that assumes the complete legal responsibility for the original production or assembly of an appliance, which includes, but is not limited to, the responsibility normally held by the manufacturer for product liability, warranty, and compliance with State and federal law. '*Manufacturer' also means a private brand packager or reassembler.*" [Emphasis added.] In the proposed regulation, staff has not addressed the key challenge of testing responsibility. If a fan is sold as stand- alone, and subsequently embedded, retesting should not be required to meet this regulation.

The draft regulation is also unclear if sales can be made outside the regulated performance bubble. How would this be enforced? Manufactures cannot verify application conditions, if even known by the consumer. It should also be acknowledged that generally these application conditions are incorrect. Field modifications are common after units have been shipped (even for engineered to order products). Performance data for embedded fans is included in the whole product performance, not simply as fan data. Standard air density needs to be used for whole product performance listings and labeling. However, the AMCA 210 procedure corrects barometric conditions using power and pressure. Draft regulatory language, as currently written will be a problem for high altitude locations as fan performance listings in airflow instead of airflow at standard density. Product data provided for these locations will be significantly different from listings in the database. In the event that CEC wrongly decides to include any fan

embedded in regulated air-conditioning equipment, SCFM needs to be used to be consistent with federal regulations.

An Embedded-fan Regulation Will Increase Cost to California Consumers

Should CEC decide to move forward with an embedded fan regulation, it will certainly violate Section 25402(c)(1) of the California Public Resources Code mandating that the Commission reduce the inefficient consumption of energy by prescribing efficiency standards. Embedded fans are largely regulated on the product level. Further, the basic concept behind fan standards is that some portion of fans operate in conditions where an alternative fan would be more efficient either because of the type of fan (e.g. backward curved vs. forward curved centrifugal fans), size of fan, fan speed or other factors. There is no evidence to suggest that changing fans embedded in larger systems actually reduces the *system's* energy consumption. California efficiency standards must be technologically feasible and attainable and must not result in any added total cost to the consumer over the designed life of the appliance. Adding a component standard will lead to costly, unnecessary redesign of product – the cost of which will be passed along to California consumers and businesses.

Conclusion

Although AHRI does not dispute that the potential exists for cost-effective, energy saving measures that could be implemented for stand-alone fans, AHRI urges the CEC to exclude all fans embedded in all residential, commercial, and industrial HVACR and water heating equipment from the scope and pursue a stand-alone commercial and industrial fans regulation which, at minimum, preserves all negotiated exclusions and provisions resulting from the Department of Energy (DOE) Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) Commercial and Industrial Fans and Blowers Working Group. Further, AHRI urges that all regulation of fans using an application-specific metric be done through Title 24.

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

Sincerely,

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Attachments:

1. US Census Bureau, Current Industrial Reports, MA35M/MA333M, Refrigeration, Air Conditioning and Warm Air Equipment, 2003-2004
2. US Census Bureau, Current Industrial Reports, MA35M/MA333M, Refrigeration, Air Conditioning and Warm Air Equipment, 2004-2005
3. AHRI Fans Presentation to CEC from November 28, 2017
4. AHRI Fans Presentation to CEC from July 11, 2018

Refrigeration, Air Conditioning, and Warm Air Heating Equipment: 2004

Issued August 2005

MA333M(04)-1

Current Industrial Reports

Current data are released electronically on Internet for all individual surveys as they become available. Use: http://www.census.gov/mcd/. Individual reports can be accessed by choosing "Current Industrial Reports (CIR)," clicking on "CIRs by Subsector;" then choose the survey of interest. Follow the menu to view the PDF file or to download the worksheet file (WK format) to your personal computer.

These data are also available on Internet through the U.S. Department of Commerce and STAT-USA by subscription. The Internet address is: www.stat-usa.gov/. Follow the prompts to register. Also, you may call 202-482-1986 or 1-800-STAT-USA, for further information.

SUMMARY OF FINDINGS

In 2004, the value of shipments of heat transfer equipment increased by 6 percent to $4,737 million, compared with the 2003 figure of $4,453 million. The value of shipments of condensing units, refrigeration (complete), increased by 11 percent to $335 million, from the 2003 level of $303 million. Room air-conditioners showed a decrease of 3 percent in 2004 with $732 million shipped, compared with the $757 million shipped in 2003. The value of shipments of motor vehicle mechanical air-conditioning systems decreased by 4 percent to $2,646 million, compared with the 2003 figure of $2,746. Compressors and compressor units increased by 7 percent to $2,341 million, compared with $2,189 million in 2003. Automotive air-conditioning compressors showed a decrease of 4 percent in 2004 with $1,531 million shipped, compared with the $1,583 million shipped in 2003. Nonelectric warm air furnaces and humidifers showed a 15-percent increase from $1,757 million in 2003 to a value of $2,013 million in 2004. Unitary air-conditioners increased by 9 percent to $5,861 million, from the 2003 level $5,359 million. The value of shipments of air source heat pumps increased by 19 percent to $1,486 million in 2004, compared to the 2003 figure of $1,241 million. The value of shipments of ground and ground water source heat pumps increased from $118 million for 2003 to $128 million in 2004, showing a 9-percent increase.

For general CIR information, explanation of general terms and historical note, see the appendix.

Address inquiries concerning these data to Investment Goods Industries Branch, Manufacturing and Construction Division (MCD), Washington, DC 20233-6900, or call Blynda K. Metcalf, 301-763-4781.

For mail or fax copies of this publication, please contact the Information Services Center, MCD, Washington, DC 20233-6900, or call 301-763-4673.

U S C E N S U S B U R E A U

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Economics and Statistics Administration
U.S. CENSUS BUREAU

Table 1. Summary of Shipments of Refrigeration, Air-Conditioning, and Warm Air Heating Equipment: 2004 and 2003

[Value in thousands of dollars]

Product code	Product description	2004	2003
3334151	Heat transfer equipment	4,737,309	4,453,257
3334153 pt.	Commercial refrigeration equipment	188,824	182,383
3334155	Condensing units, refrigeration (complete)	335,361	303,252
3334156	Room air-conditioners and dehumidifiers	732,182	756,900
3363917	Motor vehicle mechanical air-conditioning systems	2,646,163	2,745,868
333415A	Compressors and compressor units	2,341,215	2,189,182
336391B	Automotive air-conditioning compressors	1,531,011	1,583,199
333415C	Nonelectric warm air furnaces and humidifiers	2,013,247	1,757,262
333415E	Unitary air conditioners	5,861,072	5,359,148
333415F	Air source heat pumps	1,485,723	1,241,342
333415G	Ground and ground water source heat pumps	128,498	117,790

pt. Part.

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2004 and 2003
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2004 Quantity		2004 Value		2003 Quantity		2003 Value	
3334151	Heat transfer equipment (except room and unitary air-conditioners)	135	(X)		4,737,309		(X)		4,453,257	
3334151101	Packaged terminal air-conditioners 1/	7	a/	112,536	a/	74,140	108,199		69,911	
3334151103	Package terminal heat pumps	5	c/	75,041	c/	38,848	86,911		46,564	
	Evaporative condensers	(X)		2,120		58,735	r/	2,258		53,053
3334151105	100 tons and under	11		656		6,199	r/	658	r/	6,119
3334151107	Over 100 tons	12		1,464	a/	52,536	1,600		46,934	
	Room fan-coil air conditioning units:									
3334151109	Vertical stack	3	c/	8,772	c/	8,018	8,773		7,691	
3334151111	Vertical	8		97,232		84,799	100,906		82,195	
3334151113	Horizontal	8	a/	107,137		50,844	a/	102,387	46,010	
3334151115	Room air-induction units	2		(D)		(D)	(D)		(D)	
	Central station air-handling units (motor-driven fan-type)	(X)		391,139		747,416	373,588		716,302	
3334151117	Draw through	24	c/	374,226		607,930	c/	353,840	579,349	
3334151119	Blow through	10		5,415		101,446	6,927	r/	95,164	
3334151121	Heating and ventilating	10	c/	11,498		38,040	c/	12,821	r/	41,789
	Coolers (refrigeration):									
	Ceiling, wall-mounted, and floor-mounted unit coolers	(X)		215,128		146,382	218,708		139,129	
3334151123	4,000 Btuh and below	7		57,987		12,424	58,929		9,728	
3334151125	4,001 to 6,000 Btuh	7		12,680		3,991	11,287		3,133	
3334151127	6,001 to 8,000 Btuh	7		24,321		10,360	27,231		10,988	
3334151129	8,001 to 12,000 Btuh	7		48,606		21,437	47,058		19,619	
3334151131	12,001 to 18,000 Btuh	8		35,833		22,668	37,066		21,743	
3334151133	Over 18,000 Btuh	12		35,701		75,502	37,137		73,918	
	Air cooled refrigerant condensers remote type)	(X)		22,796		66,887	24,877		71,746	
3334151135	Under 30 tons	13		15,705		17,186	17,809	r/	18,951	
3334151137	30 to 50 tons	9		1,786		6,812	1,913		7,556	
3334151139	Over 50 tons	8		5,305		42,889	5,155		45,239	
	Miscellaneous heat transfer equipment:									
	Shell- and-tube, shell-and-coil, shell-and-u-tube, tube-in-tube	(X)		(X)		51,535	(X)		50,447	
3334151141	Condensers	6		(X)		24,726	(X)		26,244	
3334151143	Liquid coolers	9		(X)		26,809	(X)		24,203	
3334151145	Liquid-suction heat exchangers and refrigerant liquid receivers	7		(X)		5,792	(X)	r/	3,145	
	Central system finned coils (air-conditioning and refrigeration type	(X)		(X)		70,706	(X)		73,418	
3334151147	Standard steam and steam distributing tube	11		(X)		19,217	(X)	a/	22,052	
3334151149	Standard water cooling and/or heating and cleanable tube water	12		(X)		45,757	(X)	a/r/	47,033	
3334151151	Volatile refrigerant cooling	9		(X)		5,732	(X)	r/	4,333	
	Coil sales by original equipment manufacturers intended for resale or assembly into equipment by other manufacturer (all types)	(X)		(X)		462,954	(X)	r/	367,450	
3334151153	Copper and aluminum	15		(X)		325,406	(X)	r/	254,771	
3334151155	Aluminum (only)	7		(X)		62,297	(X)		51,566	
3334151157	Other, including steel and copper	7		(X)		75,251	(X)		61,113	
3334151159	Factory-assembled, refrigeration type, finned gravity coils, including wetted-surface dehumidifiers	3		(X)		(D)	(X)		(D)	
	Centrifugal liquid chilling packages, hermetic and open types	(X)		6,241		564,066	6,451		563,146	
3334151161	200 hp and under	10	c/	1,260		30,960	c/	1,358	34,642	
3334151163	201 to 300 hp	7		814		49,522	1,076		61,081	
3334151165	301 to 400 hp	6		1,094		76,702	1,116		75,235	
3334151167	Over 400 hp	6		3,073		406,882	2,901		392,188	
	Ice-making machines	(X)		383,601		613,039	353,219		563,752	
	Self-contained ice-cube makers	(X)		179,779		205,219	204,940		246,215	
3334151169	Automatic, under 200 lbs	6		131,773		103,802	120,007		92,782	
3334151171	Automatic, 201 lbs and over	7		48,006	a/	101,417	84,933	a/	153,433	
	Self-contained flake or chip machines	(X)		15,824		36,826	15,302		35,001	
3334151173	300 lbs and under	5	a/	3,153	a/	4,951	a/	2,761	a/	4,188
3334151175	Over 300 lbs	13	b/	12,671	c/	31,875	c/	12,541	c/	30,813
3334151177	Not self-contained	8		116,473		208,502	72,335		144,257	
3334151179	Combination ice makers and ice/drink dispensers	6		71,525		162,492	60,642		138,279	
3334151181	Absorption refrigeration and dehydration systems	5		4,824		52,453	c/	3,975	a/	44,290
3334151183	Mechanical refrigeration systems used on all types of vehicles	4		(D)		(D)	(D)		(D)	
	Reciprocating air and reciprocating water cooled, air cooled screw, air cooled scroll, and water cooled scroll machines	(X)		30,746		447,357	30,213		453,938	
3334151185	20 hp and under	22		8,106	a/	37,789	a/	8,455	35,308	
3334151187	21 to 49 hp	19		9,784		45,937	6,718		39,486	
3334151189	50 to 75 hp	17		5,815		75,756	6,597		75,027	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2004 and 2003
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2004 Quantity		2004 Value		2003 Quantity		2003 Value	
3334151191	Over 75 hp	15	7,041		287,875		8,443		304,117	
3334151193	Factory-fabricated water cooling towers	12	9,016	a/	212,347	a/	8,594	a/	197,499	
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	5	757,244	a/	188,824	r/	768,908		182,383	
3334155	Condensing units, refrigeration (complete)	25	488,383	c/	335,361	c/	477,407	c/	303,252	
	Air-cooled hermetic-type	(X)	478,188		272,963		467,000		251,651	
3334155123	1 hp and under	11	380,946		140,988		375,699		132,682	
3334155125	1.5 hp	10	23,786		17,783		22,103		15,674	
3334155128	2 hp and 2.5 hp	11	25,210		23,485		23,394		20,956	
3334155130	3 hp	10	22,130		26,477		21,188		24,162	
3334155132	Over 3 hp but under 15 hp	13	26,116		64,230		24,616		58,177	
3334155144	Water-cooled hermetic-type, under 15 hp	2	(D)		(D)		(D)		(D)	
	Water- or air-cooled hermetic-type	(X)	6,223		56,544		6,068		46,516	
3334155161	15 hp	9	1,704		8,593		1,984		9,240	
3334155163	20 hp	11	1,239		7,986		955		5,964	
3334155165	25 hp	11	949		7,835		838		5,770	
3334155167	30 hp	9	851		9,275		924		8,951	
3334155170	40 hp	9	1,480		22,855		1,367		16,591	
3334155180	Water or air-cooled open-type.(all sizes)	4	(D)		(D)		(D)		(D)	
3334156	Room air-conditioners and dehumidifiers	17	(X)		732,182		(X)		756,900	
3334156111	Electrically operated dehumidifiers, mechanically refrigerated, self-contained	6	574,926		89,518		506,247	r/	74,310	
	Room air-conditioners	(X)	3,666,121		642,664		3,939,238		682,590	
3334156131	5,999 Btuh and under	6	(D)		(D)		(D)		(D)	
3334156134	6,000 to 6,999 Btuh	5	(D)		(D)		437,057		46,179	
3334156138	7,000 to 7,999 Btuh	6	27,155	c/	7,549		201,699		33,055	
3334156142	8,000 to 8,999 Btuh	7	645,035	c/	93,726		538,686		83,344	
3334156146	9,000 to 9,999 Btuh	6	11,753	c/	3,724		19,674		6,061	
3334156152	10,000 to 10,999 Btuh	8	412,421	c/	73,658		541,392		98,147	
3334156156	11,000 to 12,999 Btuh	10	546,628	c/	117,236		613,582		134,291	
3334156161	13,000 to 14,999 Btuh	9	(D)		(D)		(D)		(D)	
3334156163	15,000 to 16,999 Btuh	7	196,321	c/	51,209		138,579		35,543	
3334156165	17,000 to 19,999 Btuh	8	238,019	c/	66,043		207,673		59,858	
3334156167	20,000 to 22,999 Btuh	6	7,342		2,902		(D)		(D)	
3334156171	23,000 to 25,999 Btuh	10	213,872	c/	77,860		170,513		63,936	
3334156175	26,000 Btuh and over	9	33,256	c/	25,221		30,389		24,298	
3363917	Motor vehicle mechanical air-conditioning systems	(X)	(X)		2,646,163		(X)		2,745,868	
3363917110	Air-conditioning units and systems for passenger automobiles 2/	22	19,739,040		1,837,561	r/	20,847,127		1,958,543	
3363917120	Air-conditioning units and systems for buses	9	330,574	c/	117,009	a/	300,741	c/r/	119,882	
3363917130	Other motor vehicle mechanical air-conditioning systems	15	3,707,778		691,593		3,582,929		667,443	
333415A	Compressors and compressor units 3/ 4/	25	(X)		2,341,215		(X)		2,189,182	
	All refrigerants (except ammonia)	(X)	11,218,332		2,262,757		11,379,562		2,117,532	
	Hermetic-type motor compressors	(X)	11,211,238		2,194,810		11,368,917		2,051,276	
333415A111	Under 3 hp	8	6,204,680		984,839		6,882,860	r/	924,201	
333415A123	3 to 10 hp	11	(D)		(D)		4,421,868		982,099	
333415A130	15 hp	10	15,135		14,589		18,052		19,736	
333415A132	20 hp	10	7,156		11,585		10,010		18,303	
333415A134	25 hp	10	6,371		10,741		8,629		16,146	
333415A136	30 hp	10	2,476		7,822		4,393		13,773	
333415A139	40 hp and 50 hp	10	5,141		35,009		15,975		42,738	
333415A142	60 hp	8	(D)		(D)		(D)		(D)	
333415A146	75 hp	5	(D)		(D)		(D)		(D)	
333415A149	100 hp and over	6	1,622		9,395		3,253		17,777	
333415A152	Open-type compressors (with or without motor, all sizes)	10	(D)		(D)		(D)		(D)	
333415A154	Screw type	4	(D)		(D)		(D)		(D)	
333415A158	Ammonia refrigerants (all types)	7	1,822	a/	78,458	a/	1,571		71,650	
336391B100	Automotive air-conditioning compressors (open-type, with or without motor)	9	13,953,372		1,531,011		14,292,443		1,583,199	
333415C pt.	Nonelectric warm air furnaces and humidifiers	(X)	(X)		2,013,247		(X)		1,757,262	
	Oil, forced air:									
333415C101	150,000 Btuh bonnet output and under	14	91,283		68,971		99,291		73,043	
333415C105	150,001 Btuh bonnet output and over	11	3,751	a/	5,868		5,129		6,337	
	Gas, forced air:									
333415C107	150,000 Btuh bonnet output and under	16	3,758,684		1,707,926		3,238,094		1,463,550	
333415C109	150,001 - 400,000 Btuh bonnet output	11	13,844		10,320		11,144		8,863	
333415C111	Over 400,000 Btuh bonnet output	8	330,711	c/	141,808	c/	287,266	c/	123,483	
333415C179	All other nonelectric warm air furnaces	5	1,640	a/	1,497		5,999		2,404	
333415C181	Humidifiers (attachments to warm air furnaces) all types, including central systems and self-contained (except portable humidifiers)	13	624,458	a/	76,857		647,483	a/	79,582	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2004 and 2003
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2004 Quantity		2004 Value		2003 Quantity		2003 Value	
333415E	Unitary air conditioners	57	(X)		5,861,072		(X)		5,359,148	
333415E105	Recreational vehicle air-conditioners	5	(D)		(D)		(D)		(D)	
	Single package air-conditioners, with or without evaporator fans, including refrigeration chassis and remote-condenser type	(X)	(D)		(D)		(D)		(D)	
	Horizontal	(X)	232,143		585,015		214,935		549,465	
333415E107	Under 27,000 Btuh	13	19,052	c/	14,466	c/	18,709		15,682	
333415E109	27,000 to 32,999 Btuh	13	27,065		25,206		18,783		17,590	
333415E111	33,000 to 53,999 Btuh	14	78,333	a/	73,386	a/	67,723		67,295	
333415E113	54,000 to 64,999 Btuh	14	44,394	a/	58,111	a/	45,388		61,513	
333415E115	65,000 to 96,999 Btuh	11	20,043		38,125		20,767		45,468	
333415E117	97,000 to 134,999 Btuh	11	14,586		42,667		16,569		52,471	
333415E119	135,000 to 184,999 Btuh	11	11,291		47,262		10,420		47,056	
333415E121	185,000 to 249,999 Btuh	12	6,060		42,667		6,486		47,212	
333415E123	250,000 to 319,999 Btuh	10	4,703		33,011		5,093		42,768	
333415E135	320,000 to 379,999 Btuh	11	1,518		25,537		1,215		19,816	
333415E141	380,000 Btuh and over	10	5,098	a/	184,577		3,782	a/	132,594	
	Other than horizontal	(X)	(D)		(D)		(D)		(D)	
333415E143	Under 54,000 Btuh	5	(D)		(D)		16,074		18,998	
333415E145	54,000 to 64,999 Btuh	4	4,451		8,856		2,216		5,260	
333415E147	65,000 to 96,999 Btuh	4	411		1,421		331		1,212	
333415E149	97,000 to 134,999 Btuh	4	(D)		(D)		(D)		(D)	
333415E151	135,000 to 184,999 Btuh	3	217		1,703	r/	237		2,015	
333415E153	185,000 Btuh and over	4	(D)		(D)		921		19,149	
	Year-round air-conditioners, single package and remote-condenser type (except heat pumps)	(X)	603,638		1,468,805		606,983		1,405,275	
333415E155	Under 33,000 Btuh	15	124,971		107,902		134,552		114,474	
333415E157	33,000 to 38,999 Btuh	15	108,791		121,045		114,632		129,000	
333415E159	39,000 to 43,999 Btuh	12	31,515		33,597		28,928		30,241	
333415E161	44,000 to 53,999 Btuh	13	75,812		104,195		76,247		104,321	
333415E163	54,000 to 64,999 Btuh	18	101,966		211,152		97,320		188,964	
333415E165	65,000 to134,999 Btuh	11	99,212		317,900		98,684		306,300	
333415E167	135,000 to 184,999 Btuh	11	32,798		188,560		28,525		161,386	
333415E169	185,000 to 249,999 Btuh	13	15,495		136,870		14,883		127,880	
333415E171	250,000 to 319,999 Btuh	10	6,717		67,052		6,858		66,042	
333415E173	320,000 to 379,999 Btuh	10	1,949		31,009		2,041		30,480	
333415E175	380,000 to 539,999 Btuh	8	1,919		36,555		1,749		33,083	
333415E177	540,000 to 639,999 Btuh	8	960		24,586		999		29,569	
333415E179	640,000 Btuh and over	8	1,533		88,382		1,565		83,535	
333415E181	Water source heat pumps (except room air-conditioners)	9	132,206	c/	152,685	a/	123,974		142,834	
	Split system air-conditioning condensing units	(X)	4,992,634		2,548,907		4,455,382		2,285,111	
333415E182	Under 22,000 Btuh	13	308,723		104,451		295,657		99,009	
333415E183	22,000 to 26,999 Btuh	14	962,682		346,250		882,186	r/	314,336	
333415E185	27,000 to 32,999 Btuh	15	879,268		368,403		796,817		331,724	
333415E187	33,000 to 38,999 Btuh	14	1,121,045		528,418		983,715		461,989	
333415E189	39,000 to 43,999 Btuh	13	505,932		277,250		441,063		240,956	
333415E191	44,000 to 53,999 Btuh	14	640,914		399,274		559,765		345,845	
333415E193	54,000 to 64,999 Btuh	12	515,403		366,687		434,739		324,517	
333415E195	65,000 to 96,999 Btuh	7	24,204		30,804		24,160		31,404	
333415E197	97,000 to 134,999 Btuh	7	13,868		24,348		16,440		31,593	
333415E199	135,000 to 184,999 Btuh	7	9,210		26,870		9,584		28,532	
333415E19A	185,000 to 249,999 Btuh	7	4,568		18,347		5,009		20,719	
333415E19C	250,000 to 319,999 Btuh	4	1,835		9,663		1,565		8,707	
333415E19E	320,000 to 379,999 Btuh	4	1,757		11,309		1,527		9,841	
333415E19G	380,000 to 539,999 Btuh	4	1,354		11,720		1,314		11,213	
333415E19J	540,000 to 639,999 Btuh	4	707		7,689		705		7,638	
333415E19L	640,000 Btuh and over	3	1,164		17,424		1,136		17,088	
	Split system air-conditioning coils	(X)	3,891,209		862,768		3,424,956		763,346	
333415E19M	With blower	10	2,075,205		632,536		1,767,158		553,836	
333415E19P	Without blower	13	1,816,004	a/	230,232	a/	1,657,798		209,510	
333415F	Air source heat pumps (except room air-conditioners)	21	1,848,530	a/	1,485,723		1,581,446		1,241,342	
	Single package:									
333415F123	Under 27,000 Btuh	15	33,468	a/	28,666		38,070		33,450	
333415F134	27,000 to 41,999 Btuh	16	88,173	a/	91,096		89,716		99,485	
333415F145	42,000 to 64,999 Btuh	16	78,466	a/	99,880		77,515		104,421	
333415F156	65,000 Btuh and over	9	12,703		44,148		15,179		51,508	
	Split system:									
333415F167	Under 27,000 Btuh	11	520,123	a/	261,271	a/	428,042		212,744	
333415F178	27,000 to 41,999 Btuh	12	721,760		516,491		608,124		418,449	
333415F189	42,000 to 64,999 Btuh	11	380,418		417,667		309,505		289,449	
333415F195	65,000 Btuh and over	7	13,419		26,504	r/	15,295	r/	31,836	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2004 and 2003
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2004 Quantity		2004 Value	2003 Quantity	2003 Value
333415G	Ground and ground water source heat pumps	5	75,519	a/	128,498	61,807	117,790
	Single and split systems:						
333415G110	Under 27,000 Btuh	3	(D)		(D)	(D)	(D)
333415G120	27,000 to 41,999 Btuh	3	(D)		(D)	(D)	(D)
333415G130	42,000 to 64,999 Btuh	3	(D)		(D)	(D)	(D)
333415G140	65,000 Btuh and over	4	(D)		(D)	(D)	(D)

Btuh British thermal units per hour. D Withheld to avoid disclosing data for individual companies. pt. Part. r/Revised by 5 percent or more from previously published data. X Not applicable.

1/Defined as factory-selected combinations of heating and cooling components or assemblies intended to serve an individual room and comprising: (1) heating assembly available with element for use with hot water, steam, and electricity; means for forced heated air circulation and distribution; integral or remote temperature controls; (2) slide-in cooling section with complete refrigerant cycle; (3) room cabinet; (4) provision for outdoor air intake and discharge and accessories as required for mounting in a building wall; (5) provisions for air filtration and ventilation; (6) permanent individual branch circuit wiring with a suitable line cord or terminating at a junction box within the room cabinet; and (7) provision for free conditioned air distribution, or when forced circulation is employed for minimal duct work having a total external static resistance not exceeding 1/10 inch of water.

2/Data exclude systems assembled from purchased components and installed at passenger automobile assemby lines. The values are understated for some systems because of the exclusion of compressors.

3/Represents only those compressors and compressor units produced and shipped separately, including interplant transfers.

4/Includes units shipped for household refrigerators.

Note: Percent of estimation for each item is indicated as follows: a/15 to 25 percent of this item is estimated. b/26 to 50 percent of this item is estimated. c/Over 50 percent of this item is estimated.

Table 3. Quantity of Assembled Compressor Bodies: 2004 and 2003
[Quantity of number units]

Product description	No. of cos.	2004	2003
Compressor bodies 1/ 2/	(X)	15,865,020	15,474,236
All refrigerants (except ammonia)	(X)	12,947,148	12,250,010
1/4 hp and under	3	(D)	(D)
1/3 hp and 1/2 hp	4	(D)	(D)
3/4 hp and 1 hp	4	(D)	(D)
1 1/2 hp	4	(D)	(D)
2 hp	6	(D)	(D)
3 hp	10	(D)	4,509,915
4 hp	4	129,697	215,725
5 hp	8	1,083,356	1,049,985
7 1/2 hp	9	94,962	86,146
10 hp	13	(D)	(D)
15 hp	12	142,019	134,237
20 hp	10	11,744	15,481
25 hp	11	10,969	13,258
30 hp	12	(D)	23,803
40 hp	11	10,518	12,140
50 hp	9	(D)	(D)
60 hp	10	4,701	4,987
75 hp	10	3,744	4,007
100 hp and over	10	25,078	21,981
Automotive air-conditioning, including passenger automobiles, trucks, buses, agriculture, and construction equipment	3	2,825,647	3,182,270
Ammonia refrigerants	2	(D)	(D)

D Withheld to avoid disclosing data for individual companies. X Not applicable.

1/Includes units for household refrigerators.

2/Represents the total number of compressor bodies assembled, whether shipped separately or incorporated into a condensing package or unitary end-use product such as single package air-conditioners freezers, and refrigerators (manufactured and remanufactured units).

Table 4. Shipments, Exports, Imports, and Apparent Consumption of Air-Conditioning and Refrigeration Equipment: 2004 and 2003
[Value in thousands of dollars]

Product code 1/	Product description	Manufactures' shipments (value f.o.b. plant)	Exports of domestic merchandise (value at port) 1/2/	Imports for consumption 3/4/
	2004			
3334151	Heat transfer equipment, excluding room and unitary air-conditoners and dehumidifiers	4,737,309	312,977	139,780
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	188,824	15,592	108,211
3334155	Condensing units, all refrigerants	335,361	37,479	36,454
3334156	Room air-conditioners and dehumidifiers	732,182	51,307	1,025,066
3363917	Motor vehicle mechanical air-conditioning systems	2,646,163	(NA)	(NA)
333415A	Compressors and compressor units, all refrigerants	2,341,215	1,079,623	1,343,961
336391B	Automotive air-conditioning compressors	1,531,011	(NA)	(NA)
333415C pt.	Nonelectric warm air furnaces and humidifiers	2,013,247	(NA)	(NA)
333415E	Unitary air-conditioners	5,861,072	259,614	314,530
333415F	Air source heat pumps	1,485,723	(NA)	(NA)
333415G	Ground and ground water source heat pumps	128,498	(NA)	(NA)
	2003			
3334151	Heat transfer equipment, excluding room and unitary air-conditoners and dehumidifiers	4,453,257	214,339	107,812
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	182,383	13,312	91,555
3334155	Condensing units, all refrigerants	303,252	36,911	29,785
3334156	Room air-conditioners and dehumidifiers	756,900	67,986	1,030,481
3363917	Motor vehicle mechanical air-conditioning systems	2,745,868	(NA)	(NA)
333415A	Compressors and compressor units, all refrigerants	2,189,182	949,870	1,221,650
336391B	Automotive air-conditioning compressors	1,583,199	(NA)	(NA)
333415C pt.	Nonelectric warm air furnaces and humidifiers	1,757,262	(NA)	(NA)
333415E	Unitary air-conditioners	5,359,148	253,081	310,522
333415F	Air source heat pumps	1,241,342	(NA)	(NA)
333415G	Ground and ground water source heat pumps	117,790	(NA)	(NA)

NA Not available. pt. Part.

1/Source: Census Bureau report EM 545, U.S. Exports (see Table 5 for a comparison of North American Industry Classification System (NAICS)-based product codes with Schedule B export codes, and HTSUSA import codes.
2/Dollar value represents the c.i.f. (cost, insurance, and freight) value at the port of export.
3/Source: Census Bureau report IM 145, U.S. Imports for Consumption. Data include both import value and duty value.
4/Represents the c.i.f. (cost, insurance, and freight) value at the first port of entry in the United States plus U.S. import duties.

Table 5. Comparison of North American Industry Classification System (NAICS-Based) Product Codes with Schedule B Export Codes, and HTSUSA Import Codes: 2004

Product code	Product description	Export code 1/	Import code 2/
3334151	Heat transfer equipment	8415.82.0130	8415.82.0130
		8415.82.0135	8415.82.0135
		8415.83.0140	8415.83.0140
		8418.61.0010	8418.61.0010
		8418.61.0015	8418.61.0015
		8418.61.0045	8418.61.0045
		8418.61.0050	8418.61.0050
		8418.61.0060	8418.61.0060
		8418.69.0055	8418.69.0055
3334153146	Mechanical drinking water coolers	8418.61.0020	8418.61.0020
3334155	Refrigeration condensing units	8418.99.0005	8418.99.8005
		8418.99.0010	8418.99.8010
		8418.99.0015	8418.99.8015
		8418.99.0020	8418.99.8020
		8418.99.0025	8418.99.8025
3334156	Room air-conditioners and dehumidifiers	8415.10.3040	8415.10.3040
		8415.10.3060	8415.10.3060
		8415.10.3080	8415.10.3080
		8415.82.0150	8415.82.0155
			8415.82.0160
3363917	Motor vehicle mechanical air-conditioning systems 3/	(X)	(X)
333415A	Compressors and compressor units, all refrigerants	8414.30.4000	8414.30.4000
		8414.30.8010	8414.30.8010
		8414.30.8020	8414.30.8020
		8414.30.8030	8414.30.8030
		8414.30.8050	8414.30.8050
		8414.30.8060	8414.30.8060
		8414.30.8070	8414.30.8070
		8414.30.8080	8414.30.8080
		8414.30.8090	8414.30.8090
336391B	Automotive air-conditioning compressors 3/	(X)	(X)
333415C	Nonelectric warm air furnaces and humidifiers 3/	(X)	(X)
333415E	Unitary air-conditioners (except room)	8415.81.0110	8415.81.0110
		8415.81.0120	8415.81.0120
		8415.81.0130	8415.81.0130
		8415.82.0105	8415.82.0105
		8415.82.0110	8415.82.0110
		8415.82.0115	8415.82.0115
		8415.82.0120	8415.82.0120
		8415.83.0050	8415.83.0050
		8415.83.0060	8415.83.0060
333415F	Air source heat pumps 3/	(X)	(X)
333415G	Ground and ground water source heat pumps 3/	(X)	(X)

X Not applicable

1/Source: 2004 edition, Harmonized System-based Schedule B, Statistical Classification of Domestic and Foreign Commodities Exported from the United States.

2/Source: Harmonized Tariff Schedule of the United States, Annotated (2004).

3/Import-export classification not directly comparable.

Appendix.
General CIR Survey Information, Explanation of General Terms and Historical Note

GENERAL

The CIR program has been providing monthly, quarterly, and annual measures of industrial activity for many years. Since 1904, with its cotton and fats and oils surveys, the CIR program has formed an essential part of an integrated statistical system involving the quinquennial economic census, manufacturing sector, and the annual survey of manufactures. The CIR surveys, however, provide current statistics at a more detailed product level than either of the other two statistical programs.

The primary objective of the CIR program is to produce timely, accurate data on production and shipments of selected products. The data are used to satisfy economic policy needs and for market analysis, forecasting, and decision making in the private sector. The product-level data generated by these surveys are used extensively by individual firms, trade associations, and market analysts in planning or recommending marketing and legislative strategies, particularly if their industry is significantly affected by foreign trade. Although production and shipments information are the two most common data items collected, the CIR program collects other measures also such as inventories, orders, and consumption. These surveys measure manufacturing activity in important commodity areas such as textiles and apparel, chemicals, primary metals, computer and electronic components, industrial equipment, aerospace equipment, and consumer goods.

The CIR program uses a unified data collection, processing, and publication system. The U.S. Census Bureau updates the survey panels for most reports annually and reconciles the estimates to the results of the broader-based annual survey of manufactures and the economic census, manufacturing sector. The manufacturing sector provides a complete list of all producers of the products covered by the CIR program and serves as the primary source for CIR sampling. Where a small number of producers exist, CIR surveys cover all known producers of a product. However, when the number of producers is too large, cutoff and random sampling techniques are used. Surveys are continually reviewed and modified to provide the most up-to-date information on products produced. The CIR program includes a group of mandatory and voluntary surveys. Typically the monthly and quarterly surveys are conducted on a voluntary basis. Those companies that choose not to respond to the voluntary surveys are required to submit a mandatory annual counterpart corresponding to the more frequent survey.

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS), 1997

The adoption of the North American Industry Classification System (NAICS) in the 1997 Economic Census has had a major impact on the comparability of current and historic data. Approximately half of the industries in the manufacturing sector of NAICS do not have comparable industries in the Standard Industrial Classification (SIC) system that was used in the past.

While most of the change affecting the manufacturing sector was change within the sector, some industries left manufacturing and others came into manufacturing. Prominent among those that left manufacturing are logging and portions of publishing. Prominent among the industries that came into the manufacturing sector are bakeries, candy stores where candy is made on the premises, custom tailors, makers of custom draperies, and tire retreading. The net effect of the classification changes are such that if the 1997 value of shipments data for all manufacturers were tabulated on an SIC basis, it would be approximately 3 percent higher.

Listed below are the NAICS sectors:

21 Mining
22 Utilities
23 Construction
31-33 Manufacturing
42 Wholesale Trade
44-45 Retail Trade
48-49 Transportation and Warehousing
51 Information
52 Finance and Insurance
53 Real Estate and Rental and Leasing
54 Professional, Scientific, and Technical Services
55 Management of Companies and Enterprises
56 Administrative and Support and Waste Management and Remediation Services
61 Educational Services
62 Health Care and Social Assistance
71 Arts, Entertainment, and Recreation
72 Accommodation and Food Services
81 Other Services (except Public Administration)

(Not listed above are the Agriculture, Forestry, Fishing, and Hunting sector (NAICS 11), partially covered by the census of agriculture conducted by the U.S. Department of Agriculture, and the Public Administration sector (NAICS 92), covered by the census of governments conducted by the Census Bureau.)

The 20 NAICS sectors are subdivided into 96 subsectors (three-digit codes), 313 industry groups (four-digit codes), and, as implemented in the United States, 1170 industries (five- and six-digit codes).

FUNDING

The Census Bureau funds most of the surveys. However, a number of surveys are paid for either fully or partially by other Federal Government agencies or private trade associations. A few surveys are mandated, but all are authorized by Title 13 of the United States Code.

RELIABILITY OF DATA

Survey error may result from several sources including the inability to obtain information about all cases in the survey, response errors, definitional difficulties, differences in the interpretation of questions, mistakes in recording or coding the reported data, and other errors of collection, response, coverage, and estimation. These nonsampling errors also occur in complete censuses. Although no direct measurement of the biases due to these nonsampling errors has been obtained, precautionary steps were taken in all phases of the collection, processing, and tabulation of the data in an effort to minimize their influence.

A major source of bias in the published estimates is the imputing of data for nonrespondents, for late reporters, and for data that fail logic edits. Missing figures are imputed based on period-to-period movements shown by reporting firms. A figure is considered to be an impute if the value was not directly reported on the questionnaire, directly derived from other reported items, directly available from supplemental sources, or obtained from the respondent during the analytical review phase. Imputation generally is limited to a maximum of 10 percent for any one data cell. Figures with imputation rates greater than 10 percent are suppressed or footnoted. The imputation rate is not an explicit indicator of the potential error in published figures due to nonresponse, because the actual yearly movements for nonrespondents may or may not closely agree with the imputed movements. The range of difference between the actual and imputed figures is assumed to be small. The degree of uncertainty regarding the accuracy of the published data increases as the percentage of imputation increases. Figures with imputation rates above 10 percent should be used with caution.

DATA REVISIONS

Statistics for previous years may be revised as the result of corrected figures from respondents, late reports for which imputations were originally made, or other corrections. Data that have been revised by more than 5 percent from previously published data are indicated by footnotes.

DISCLOSURE

The Census Bureau collects the CIR data under the authority of Title 13, United States Code, which specifies that the information can only be used for statistical purposes and cannot be published or released in any manner that would identify a person, household, or establishment. "D" indicates that data in the cell have been suppressed to avoid disclosure of information pertaining to individual companies.

EXPLANATION OF GENERAL TERMS

Capacity. The maximum quantity of a product that can be produced in a plant in 1 day if operating for 24 hours. Includes the capacity of idle plants until the plant is reported to be destroyed, dismantled, or abandoned.

Consumption. Materials used in producing or processing a product or otherwise removing the product from the inventory.

Exports. Includes all types of products shipped to foreign countries, or to agents or exporters for reshipment to foreign countries.

Gross shipments. The quantity or value of physical shipments from domestic establishments of all products sold, transferred to other establishments of the same company, or shipped on consignment, whether for domestic or export sale or use. Shipments of products purchased for resale are omitted. Shipments of products made under toll arrangements are included.

Interplant transfers. Shipments to other domestic plants within a company for further assembly, fabrication, or manufacture.

Inventories. The quantity or value of finished goods, work in progress, and materials on hand.

Machinery in place. The number of machines of a particular type in place as of a particular date whether the machinery was used for production, prototype, or sampling, or was idle. Machinery in place includes all machinery set up in operating positions.

Net receipts. Derived by subtracting the materials held at the end of the previous month from the sum of materials used during the current month.

Production. The total volume of products produced, including: products sold; products transferred or added to inventory after adjustments for breakage, shrinkage, and obsolescence, plus any other inventory adjustment; and products that undergo further manufacture at the same establishment.

Quantities produced and consumed. Quantities of each type of product produced by a company for internal consumption within that same company.

Quantity and value of new orders. The sales value of orders received during the current reporting period for products and services to be delivered immediately or at some future date. Also represents the net sales value of contract change documents that increase or decrease the sales value of the orders to which they are related, when the parties concerned are in substantial agreement as to the amount involved. Included as orders are only those that are supported by binding legal documents such as signed contracts or letter contracts.

Quantity and value of shipments. The figures on quantity and value of shipments represent physical shipments of all products sold, transferred to other establishments of the same company, or shipped on consignment, whether for domestic or export sale. The value represents the net sales price, f.o.b. plant, to the customer or branch to which the products are shipped, net of discounts, allowances, freight charges, and returns. Shipments to a company's own branches are assigned the same value as comparable appropriate allocation of company overhead and profit. Products bought and resold without further manufacture are excluded.

Stocks. Total quantity of ending finished inventory.

Unfilled orders (backlog). Calculated by adding net new orders and subtracting net sales from the backlog at the end of the preceding year.

HISTORICAL NOTE

Data on air-conditioning and refrigeration have been collected by the Census Bureau since 1944. Historical data may be obtained from Current Industrial Reports (called Facts for Industry before 1959) available at your local Federal Depository Library.

Refrigeration, Air Conditioning, and Warm Air Heating Equipment: 2005

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Current Industrial Reports

Current data are released electronically on Internet for all individual surveys as they become available. Use: http://www.census.gov/mcd/. Individual reports can be accessed by choosing "Current Industrial Reports (CIR)," clicking on "CIRs by Subsector;" then choose the survey of interest. Follow the menu to view the PDF file or to download the worksheet file (XLS format) to your personal computer.

These data are also available on Internet through the U.S. Department of Commerce and STAT-USA by subscription. The Internet address is: www.stat-usa.gov/. Follow the prompts to register. Also, you may call 202-482-1986 or 1-800-STAT-USA, for further information.

SUMMARY OF FINDINGS

In 2005, the value of shipments of heat transfer equipment increased by 1.8 percent to $4,766 million, compared with the 2004 figure of $4,681 million. The value of shipments of condensing units, refrigeration (complete), increased by 2.3 percent to $334 million, compared to the 2004 level of $326 million. Room air conditioners showed a decrease of 1.9 percent in 2005 with $516 million shipped, compared with $526 million shipped in 2004. The value of shipments of motor vehicle mechanical air-conditioning systems increased by 4.1 percent to $2,781 million, compared to the 2004 figure of $2,670 million. Compressors and compressor units increased by 3.9 percent to $2,430 million, compared with $2,338 million in 2004. Automotive air-conditioning compressors showed a decrease of 5.5 percent in 2005 with $1,519 million shipped, compared to the $1,607 million shipped in 2004. Nonelectric warm air furnaces and humidifiers showed a 5.6-percent increase from $2,083 million in 2004 to a value of $2,200 million in 2005. Unitary air-conditioners increased by 14.9 percent to $6,997 million, from the 2004 level $6,089 million. The value of shipments of air source heat pumps increased by 21 percent to $1,752 million in 2005, compared to $1,448 million in 2004. The value of shipments of ground and ground water source heat pumps increased from $136 million for 2004 to $150 million in 2005, showing a 10.6-percent increase.

For general CIR information, explanation of general terms and historical note, see the appendix.

Address inquiries concerning these data to Investment Goods Industries Branch, Manufacturing and Construction Division (MCD), Washington, DC 20233-6900, or call Blynda K. Metcalf, 301-763-4781.

For mail or fax copies of this publication, please contact the Information Services Center, MCD, Washington, DC 20233-6900, or call 301-763-4673.

U S C E N S U S B U R E A U

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Economics and Statistics Administration
U.S. CENSUS BUREAU

Table 1. Summary of Shipments of Refrigeration, Air-Conditioning, and Warm Air Heating Equipment: 2005 and 2004

[Value in thousands of dollars]

Product code	Product description	2005	2004
3334151	Heat transfer equipment	4,766,490	4,680,792
3334153 pt.	Commercial refrigeration equipment	502,522	463,776
3334155	Condensing units, refrigeration (complete)	333,805	326,257
3334156	Room air-conditioners and dehumidifiers	516,236	526,433
3363917	Motor vehicle mechanical air-conditioning systems	2,780,776	2,670,213
333415A	Compressors and compressor units	2,429,921	2,337,880
336391B	Automotive air-conditioning compressors	1,518,681	1,606,960
333415C	Nonelectric warm air furnaces and humidifiers	2,200,210	2,083,168
333415E	Unitary air conditioners	6,996,518	6,089,160
333415F	Air source heat pumps	1,751,496	1,448,096
333415G	Ground and ground water source heat pumps	150,021	135,666

pt. Part.

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2005 and 2004
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2005 Quantity		2005 Value		2004 Quantity		2004 Value	
3334151	Heat transfer equipment (except room and unitary air-conditioners)	126	(X)		4,766,490		(X)		4,680,792	
3334151101	Packaged terminal air-conditioners 1/	8	198,116	a/	117,143	a/r/	181,680	r/	101,067	
3334151103	Package terminal heat pumps	6	164,428	a/	84,063	a/r/	146,874	a/r/	66,819	
	Evaporative condensers	(X)	2,113		63,351		2,052		57,636	
3334151105	100 tons and under	11	703		7,032		641		6,094	
3334151107	Over 100 tons	12	1,410		56,319		1,411		51,542	
	Room fan-coil air conditioning units:									
3334151109	Vertical stack	3	(D)		(D)	r/	9,323		8,238	
3334151111	Vertical	7	99,226	c/	88,057	a/	97,166		84,712	
3334151113	Horizontal	7	82,629	c/	43,249	a/	105,787		50,189	
3334151115	Room air-induction units	2	(D)		(D)		(D)		(D)	
	Central station air-handling units (motor-driven fan-type)	(X)	(D)		(D)		(D)		(D)	
3334151117	Draw through	21	56,481		556,001	r/	52,621	r/	534,973	
3334151119	Blow through	10	(D)		(D)		(D)		(D)	
3334151121	Heating and ventilating	9	11,168	c/	36,954	c/	11,468		37,744	
	Coolers (refrigeration):									
	Ceiling, wall-mounted, and floor-mounted unit coolers	(X)	208,737		155,247		214,598		144,968	
3334151123	4,000 Btuh and below	7	54,455		12,341		57,969		12,387	
3334151125	4,001 to 6,000 Btuh	7	12,154		3,924		12,571	r/	3,700	
3334151127	6,001 to 8,000 Btuh	7	24,460		10,799		24,286		10,245	
3334151129	8,001 to 12,000 Btuh	8	48,517		24,300		48,413		20,565	
3334151131	12,001 to 18,000 Btuh	9	34,975		22,992		35,639	r/	21,394	
3334151133	Over 18,000 Btuh	13	34,176		80,891		35,720		76,677	
	Air cooled refrigerant condensers remote type)	(X)	23,800		81,478		22,796		66,887	
3334151135	Under 30 tons	13	16,364	a/	30,969		15,705		17,186	
3334151137	30 to 50 tons	9	1,957		6,863		1,786		6,812	
3334151139	Over 50 tons	8	5,479		43,646		5,305		42,889	
	Miscellaneous heat transfer equipment:									
	Shell-and-tube, shell-and-coil, shell-and-u-tube, tube-in-tube	(X)	(X)		57,245		(X)		51,535	
3334151141	Condensers	6	(X)		27,355		(X)		24,726	
3334151143	Liquid coolers	9	(X)		29,890		(X)		26,809	
3334151145	Liquid-suction heat exchangers and refrigerant liquid receivers	7	(X)		5,624		(X)		5,792	
	Central system finned coils (air-conditioning and refrigeration type)	(X)	(X)		79,242		(X)		69,249	
3334151147	Standard steam and steam distributing tube	11	(X)	a/	21,422		(X)		19,217	
3334151149	Standard water cooling and/or heating and cleanable tube water	11	(X)		52224		(X)		44,300	
3334151151	Volatile refrigerant cooling	9	(X)		5,596		(X)		5,732	
	Coil sales by original equipment manufacturers intended for resale or assembly into equipment by other manufacturer (all types)	(X)	(X)		530,338		(X)		458,791	
3334151153	Copper and aluminum	16	(X)		387,351		(X)		325,406	
3334151155	Aluminum (only)	7	(X)		70,805		(X)		62,297	
3334151157	Other, including steel and copper	7	(X)		72,182		(X)	r/	71,088	
3334151159	Factory-assembled, refrigeration type, finned gravity coils, including wetted-surface dehumidifiers	3	(X)		(D)		(X)		(D)	
	Centrifugal liquid chilling packages, hermetic and open types	(X)	5,770		566,326		6,241		564,066	
3334151161	200 hp and under	11	916	c/	22,662	c/	1,260		30,960	
3334151163	201 to 300 hp	7	748		46,592		814		49,522	
3334151165	301 to 400 hp	7	1,112		83,184		1,094		76,702	
3334151167	Over 400 hp	6	2,994		413,888		3,073		406,882	
	Ice-making machines	(X)	373,451		648,143	r/	345,873		585,657	
	Self-contained ice-cube makers	(X)	144,757		173,332	r/	144,857	r/	182,273	
3334151169	Automatic, under 200 lb	5	99,728		81,945	r/	96,386	r/	80,150	
3334151171	Automatic, 201 lb and over	8	45,029	a/	91,387		48,471	a/	102,123	
	Self-contained flake or chip machines	(X)	16,290		41,447	r/	13,511	r/	33,201	
3334151173	300 lb and under	4	1,486	a/	3,143	r/	1,676	r/	3,464	
3334151175	Over 300 lb	12	14,804	b/	38,304	c/r/	11,835	a/r/	29,737	
3334151177	Not self-contained	8	127,061		239,290		115,980		207,691	
3334151179	Combination ice makers and ice/drink dispensers	6	85,343		194,074		71,525		162,492	
3334151181	Absorption refrigeration and dehydration systems	4	7,430		64,152	r/	6,146	r/	64,460	
3334151183	Mechanical refrigeration systems used on all types of vehicles	4	(D)		(D)		(D)		(D)	
	Reciprocating air and reciprocating water cooled, air cooled screw, air cooled scroll, and water cooled scroll machines	(X)	24,072		462,088	r/	28,508		443,501	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2005 and 2004
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2005 Quantity		2005 Value		2004 Quantity		2004 Value	
3334151185	20 hp and under	20	6,794		34,480	r/	7,319		36,113	
3334151187	21 to 49 hp	18	4,985		38,419	r/	8,647		45,571	
3334151189	50 to 75 hp	16	5,111		77,240	r/	5,507		76,082	
3334151191	Over 75 hp	18	7,182		311,949		7,035		285,735	
3334151193	Factory-fabricated water cooling towers	12	a/ 9,537	a/	245,130	a/	8,999	a/	212,340	
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	9	1,120,661	a/	502,522	r/	1,025,872	r/	463,776	
3334155	Condensing units, refrigeration (complete)	25	c/ 416,264	a/	333,805	a/r/	410,993		326,257	
	Air-cooled hermetic-type	(X)	406,053		270,471	r/	400,876		264,860	
3334155123	1 hp and under	12	307,812		134,575	r/	303,718	r/	133,601	
3334155125	1.5 hp	9	24,782		18,759		23,766		17,603	
3334155128	2 hp and 2.5 hp	10	25,415		24,556		25,178		23,216	
3334155130	3 hp	9	21,416		25,320		22,098		26,210	
3334155132	Over 3 hp, but under 15 hp	14	26,628		67,261		26,116		64,230	
3334155144	Water-cooled hermetic-type, under 15 hp	2	(D)		(D)		(D)		(D)	
	Water or air-cooled hermetic-type	(X)	6,094		56,414		6,145		55,543	
3334155161	15 hp	8	1,707		8,702		1,692		8,490	
3334155163	20 hp	11	1,156		7,876		1,188	r/	7,560	
3334155165	25 hp	11	850		7,060		954		7,526	
3334155167	30 hp	8	806		9,030		831		9,112	
3334155170	40 hp	11	1,575		23,746		1,480		22,855	
3334155180	Water or air-cooled open-type (all sizes)	4	(D)		(D)		(D)		(D)	
3334156	Room air-conditioners and dehumidifiers	15	(X)		516,236		(X)	r/	526,433	
3334156111	Electrically operated dehumidifiers, mechanically refrigerated, self-contained	6	587,106	a/	101,039		574,926		89,518	
	Room air-conditioners	(X)	2,168,538		415,197	r/	2,524,086	r/	436,915	
3334156131	5,999 Btuh and under	4	(D)		(D)		(D)		(D)	
3334156134	6,000 to 6,999 Btuh	4	(D)		(D)		(D)		(D)	
3334156138	7,000 to 7,999 Btuh	5	a/ 10,215	a/	3,365	r/	7,632	r/	2,495	
3334156142	8,000 to 8,999 Btuh	6	262,954		36,058		446,539		56,420	
3334156146	9,000 to 9,999 Btuh	5	(D)		(D)		(D)		(D)	
3334156152	10,000 to 10,999 Btuh	7	c/ 269,947	c/	44,200	r/	303,342	r/	49,515	
3334156156	11,000 to 12,999 Btuh	9	c/ 354,107	a/	78,380	r/	406,239	r/	80,641	
3334156161	13,000 to 14,999 Btuh	8	(D)		(D)		(D)		(D)	
3334156163	15,000 to 16,999 Btuh	6	a/ 121,290	a/	33,766	r/	108,149	r/	29,261	
3334156165	17,000 to 19,999 Btuh	7	a/ 173,411	a/	43,964	r/	176,022	r/	47,889	
3334156167	20,000 to 22,999 Btuh	6	3,314		1,980		7,342		2,902	
3334156171	23,000 to 25,999 Btuh	9	a/ 174,977	a/	61,002	r/	119,806	r/	40,574	
3334156175	26,000 Btuh and over	8	(D)		(D)		(D)		(D)	
3363917	Motor vehicle mechanical air-conditioning systems	(X)	(X)		2,780,776		(X)		2,670,213	
3363917110	Air-conditioning units and systems for passenger automobiles 2/	21	16,721,706		1,886,671	r/	17,583,976		1,860,887	
3363917120	Air-conditioning units and systems for buses	9	c/ 361,701	a/	136,307	c/	329,870	a/	116,872	
3363917130	Other motor vehicle mechanical air-conditioning systems	14	4,403,075		757,798	r/	4,320,229		692,454	
333415A	Compressors and compressor units 3/ 4/	25	(X)		2,429,921		(X)		2,337,880	
	All refrigerants (except ammonia)	(X)	12,762,478		2,335,820	r/	12,949,894		2,259,422	
	Hermetic-type motor compressors	(X)	12,756,348		2,274,097	r/	12,942,817		2,194,810	
333415A111	Under 3 hp	8	7,643,458		1,004,698	r/	7,927,963		984,839	
333415A123	3 to 10 hp	11	(D)		(D)		(D)		(D)	
333415A130	15 hp	10	12,172		14,020		15,135		14,589	
333415A132	20 hp	10	6,103		10,896		7,156		11,585	
333415A134	25 hp	10	4,623		8,955		6,371		10,741	
333415A136	30 hp	10	2,567		7,956		2,476		7,822	
333415A139	40 hp and 50 hp	10	13,401		36,225	r/	13,437		35,009	
333415A142	60 hp	8	(D)		(D)		(D)		(D)	
333415A146	75 hp	6	(D)		(D)		(D)		(D)	
333415A149	100 hp and over	6	(D)		(D)		(D)		(D)	
333415A152	Open-type compressors (with or without motor--all sizes)	9	(D)		(D)		(D)		(D)	
333415A154	Screw type	3	(D)		(D)		(D)		(D)	
333415A158	Ammonia refrigerants (all types)	5	1,671		94,101	a/r/	1,717		78,458	
336391B100	Automotive air-conditioning compressors (open-type, with or without motor)	13	13,852,177		1,518,681		14,407,374		1,606,960	
333415C pt.	Nonelectric warm air furnaces and humidifiers	(X)	(X)		2,200,210		(X)		2,083,168	
	Oil, forced air:									
333415C101	150,000 Btuh bonnet output and under	13	77,679		62,793		91,283		68,971	
333415C105	150,001 Btuh bonnet output and over	11	a/ 3,700	a/	5,939	a/	3,823	r/	5,267	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2005 and 2004
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2005 Quantity		2005 Value		2004 Quantity		2004 Value	
	Gas, forced air:									
333415C107	150,000 Btuh bonnet output and under	17	4,230,356		2,013,033	r/	4,191,209	r/	1,893,494	
333415C109	150,001-400,000 Btuh bonnet output	11	12,902		10,792		13,844		10,320	
333415C111	Over 400,000 Btuh bonnet output	8	1,836		27,224	r/	2,576	r/	27,028	
333415C179	All other nonelectric warm air furnaces	5	a/ 1,522	a/	2,284	a/	1,640	a/	1,497	
333415C181	Humidifiers (attachments to warm air furnaces) (all types), including central systems and self-contained (except portable humidifiers)	13	612,001	a/	78,145		624,070	a/	76,591	
333415E	Unitary air conditioners	57	(X)		6,996,518		(X)		6,089,160	
333415E105	Recreational vehicle air-conditioners	5	(D)		(D)		(D)		(D)	
	Single package air-conditioners, with or without evaporator fans, including refrigeration chassis and remote-condenser type	(X)	(D)		(D)		(D)		(D)	
	Horizontal	(X)	261,674		677,747		228,650	r/	695,497	
333415E107	Under 27,000 Btuh	14	c/ 24,372	c/	19,352	c/	19,373	c/	14,717	
333415E109	27,000 to 32,999 Btuh	14	31,566		30,644		27,607		25,607	
333415E111	33,000 to 53,999 Btuh	15	a/ 87,787		111,951	a/	76,162	r/	184,458	
333415E113	54,000 to 64,999 Btuh	15	50,882	a/	70,910		42,370	a/	56,885	
333415E115	65,000 to 96,999 Btuh	12	19,521		40,296		19,707		37,448	
333415E117	97,000 to 134,999 Btuh	13	15,927		49,540		14,748		43,163	
333415E119	135,000 to 184,999 Btuh	12	12,395		54,296		11,294		47,292	
333415E121	185,000 to 249,999 Btuh	13	7,071		51,618		6,066		42,740	
333415E123	250,000 to 319,999 Btuh	11	5,612		34,583		4,705		33,036	
333415E135	320,000 to 379,999 Btuh	11	1,364		23,953		1,520		25,574	
333415E141	380,000 Btuh and over	10	5,177	a/	190,604		5,098	a/	184,577	
	Other than horizontal	(X)	(D)		(D)		(D)		(D)	
333415E143	Under 54,000 Btuh	5	(D)		(D)		(D)		(D)	
333415E145	54,000 to 64,999 Btuh	4	(D)		(D)		4,458		8,882	
333415E147	65,000 to 96,999 Btuh	4	550		1,786		418		1,456	
333415E149	97,000 to 134,999 Btuh	4	(D)		(D)		279		1,616	
333415E151	135,000 to 184,999 Btuh	3	327		2,417		228		1,777	
333415E153	185,000 Btuh and over	4	1,122		20,534		949		17,702	
	Year-round air-conditioners, single package and remote-condenser type (except heat pumps)	(X)	630,758		1,588,689		595,835		1,483,404	
333415E155	Under 33,000 Btuh	17	129,935		124,341		129,347		112,529	
333415E157	33,000 to 38,999 Btuh	16	118,038		144,220		111,471		124,621	
333415E159	39,000 to 43,999 Btuh	14	33,961		40,266		31,978		34,492	
333415E161	44,000 to 53,999 Btuh	14	79,632		116,092		76,035		105,370	
333415E163	54,000 to 64,999 Btuh	19	103,462		229,848		100,594		211,795	
333415E165	65,000 to134,999 Btuh	11	101,688		339,755	r/	85,009		317,749	
333415E167	135,000 to 184,999 Btuh	11	34,638		206,452		32,731		189,942	
333415E169	185,000 to 249,999 Btuh	13	17,016		153,240		15,519		137,631	
333415E171	250,000 to 319,999 Btuh	11	6,423		64,599		6,756		67,740	
333415E173	320,000 to 379,999 Btuh	11	1,997		31,605		1,966		31,360	
333415E175	380,000 to 539,999 Btuh	9	1,819		35,121		1,936		37,207	
333415E177	540,000 to 639,999 Btuh	8	951		26,702		960		24,586	
333415E179	640,000 Btuh and over	8	1,198		76,448		1,533		88,382	
333415E181	Water source heat pumps (except room air-conditioners)	10	c/ 134,585	a/	171,062	a/	135,769	a/	159,203	
	Split system air-conditioning condensing units	(X)	6,012,684		3,220,258		5,047,828		2,601,345	
333415E182	Under 22,000 Btuh	14	386,022		131,676		314,431		107,275	
333415E183	22,000 to 26,999 Btuh	14	1,267,457		478,769		996,219		362,294	
333415E185	27,000 to 32,999 Btuh	15	1,073,172		485,567		899,151		380,991	
333415E187	33,000 to 38,999 Btuh	15	1,319,595		672,659		1,122,698		538,085	
333415E189	39,000 to 43,999 Btuh	13	570,213		333,587		504,679		279,656	
333415E191	44,000 to 53,999 Btuh	15	751,811		504,825		637,933		402,050	
333415E193	54,000 to 64,999 Btuh	13	580,492		442,871		513,529		369,532	
333415E195	65,000 to 96,999 Btuh	7	26,298		34,795		24,284		31,206	
333415E197	97,000 to 134,999 Btuh	7	16,265		27,554		14,062		25,291	
333415E199	135,000 to 184,999 Btuh	7	9,926		29,312		9,266		27,229	
333415E19A	185,000 to 249,999 Btuh	7	5,056		20,954		4,622		18,723	
333415E19C	250,000 to 319,999 Btuh	5	1,747		10,300	r/	1,945	r/	10,620	
333415E19E	320,000 to 379,999 Btuh	5	1,598		10,980		1,776		11,465	
333415E19G	380,000 to 539,999 Btuh	5	1,303		11,765		1,362		11,815	
333415E19J	540,000 to 639,999 Btuh	4	654		7,428		707		7,689	
333415E19L	640,000 Btuh and over	3	1,075		17,216		1,164		17,424	
	Split system air-conditioning coils	(X)	4,143,471		1,068,262		3,880,124		905,440	
333415E19M	With blower	9	2,352,599		833,222		2,134,560	r/	683,681	
333415E19P	Without blower	12	c/ 1,790,872	a/	235,040	a/	1,745,564		221,759	

Table 2. Quantity and Value of Shipments of Refrigeration, Air-Conditioning and Warm Air Heating Equipment: 2005 and 2004
[Quantity in number of units. Value in thousands of dollars]

Product code	Product description	No. of cos.	2005 Quantity		2005 Value		2004 Quantity		2004 Value
333415F	Air source heat pumps (except room air-conditioners).....	21	a/ 2,113,944		1,751,496		1,876,524		1,448,096
	Single package:								
333415F123	Under 27,000 Btuh.....	14	37,179		33,832		33,412		28,893
333415F134	27,000 to 41,999 Btuh.....	16	105,946		115,351	r/	96,464	r/	99,140
333415F145	42,000 to 64,999 Btuh.....	16	93,064		124,752	r/	85,010	r/	107,574
333415F156	65,000 Btuh and over.....	9	14,914		49,731		13,294		43,826
	Split system:								
333415F167	Under 27,000 Btuh.....	11	571,746		314,311		508,225		261,249
333415F178	27,000 to 41,999 Btuh.....	11	847,593		636,403		747,739	r/	460,085
333415F189	42,000 to 64,999 Btuh.....	11	430,173		449,510		378,557		419,973
333415F195	65,000 Btuh and over.....	9	13,329		27,606		13,823		27,356
333415G	Ground and ground water source heat pumps.....	6	79,844		150,021		75,519	a/r/	135,666

Btuh British thermal units per hour. D Withheld to avoid disclosing data for individual companies. pt. Part. r/Revised by 5 percent or more from previously published data. X Not applicable.

1/Defined as factory-selected combinations of heating and cooling components or assemblies intended to serve an individual room and comprising: (1) heating assembly available with element for use with hot water, steam, and electricity; means for forced heated air circulation and distribution; integral or remote temperature controls; (2) slide-in cooling section with complete refrigerant cycle; (3) room cabinet; (4) provision for outdoor air intake and discharge and accessories as required for mounting in a building wall; (5) provisions for air filtration and ventilation; (6) permanent individual branch circuit wiring with a suitable line cord or terminating at a junction box within the room cabinet; and (7) provision for free conditioned air distribution, or when forced circulation is employed for minimal duct work having a total external static resistance not exceeding 1/10 inch of water.

2/Data exclude systems assembled from purchased components and installed at passenger automobile assemby lines. The values are understated for some systems because of the exclusion of compressors.

3/Represents only those compressors and compressor units produced and shipped separately, including interplant transfers.

4/Includes units shipped for household refrigerators.

Note: Percent of estimation for each item is indicated as follows: a/15 to 25 percent of this item is estimated. b/26 to 50 percent of this item is estimated. c/Over 50 percent of this item is estimated.

Table 3. Quantity of Assembled Compressor Bodies: 2005 and 2004
[Quantity of number units]

Product description	No. of cos.	2005	2004
Compressor bodies 1/ 2/	(X)	15,525,312	15,925,025
All refrigerants (except ammonia)	(X)	12,744,636	12,947,133
Under 2 hp	8	(D)	(D)
2 hp	6	(D)	(D)
3 hp	10	(D)	(D)
4 hp	4	93,310	129,697
5 hp	8	1,079,528	1,083,356
7 1/2 hp	9	106,838	94,962
10 hp	13	(D)	(D)
15 hp	12	75,945	142,019
20 hp	10	18,321	11,744
25 hp	11	9,266	10,969
30 hp	12	(D)	(D)
40 hp	11	9,365	10,518
50 hp	9	(D)	(D)
60 hp	10	4,762	4,701
75 hp	10	6,234	3,744
100 hp and over	10	15,676	25,078
Automotive air-conditioning, including passenger automobiles, trucks, buses, agriculture, and construction equipment	3	2,586,430	2,885,647
Ammonia refrigerants	2	(D)	(D)

D Withheld to avoid disclosing data for individual companies. X Not applicable.

1/Includes units for household refrigerators.

2/Represents the total number of compressor bodies assembled, whether shipped separately or incorporated into a condensing package or unitary end-use product such as single package air-conditioners, freezers, and refrigerators (manufactured and remanufactured units).

Table 4. Shipments, Exports, Imports, and Apparent Consumption of Air-Conditioning and Refrigeration Equipment: 2005 and 2004
[Value in thousands of dollars]

Product code 1/	Product description	Manufactures' shipments (value f.o.b. plant)	Exports of domestic merchandise (value at port) 1/ 2/	Imports for consumption 3/ 4/
	2005			
3334151	Heat transfer equipment, excluding room and unitary air-conditoners and dehumidifiers	4,766,490	328,959	185,759
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	502,522	19,814	113,300
3334155	Condensing units, all refrigerants	333,805	51,771	49,335
3334156	Room air-conditioners and dehumidifiers	516,236	81,631	1,011,681
3363917	Motor vehicle mechanical air-conditioning systems	2,780,776	(NA)	(NA)
333415A	Compressors and compressor units, all refrigerants	2,429,921	1,009,706	1,524,991
336391B	Automotive air-conditioning compressors	1,518,681	(NA)	(NA)
333415C pt.	Nonelectric warm air furnaces and humidifiers	2,200,210	(NA)	(NA)
333415E	Unitary air-conditioners	6,996,518	294,727	446,718
333415F	Air source heat pumps	1,751,496	(NA)	(NA)
333415G	Ground and ground water source heat pumps	150,021	(NA)	(NA)
	2004			
3334151	Heat transfer equipment, excluding room and unitary air-conditoners and dehumidifiers	4,680,792	312,977	139,780
3334153146	Commercial refrigeration equipment, mechanical drinking water coolers	463,776	15,592	108,211
3334155	Condensing units, all refrigerants	326,257	37,479	36,454
3334156	Room air-conditioners and dehumidifiers	526,433	51,307	1,025,066
3363917	Motor vehicle mechanical air-conditioning systems	2,670,213	(NA)	(NA)
333415A	Compressors and compressor units, all refrigerants	2,337,880	1,079,623	1,343,961
336391B	Automotive air-conditioning compressors	1,606,960	(NA)	(NA)
333415C pt.	Nonelectric warm air furnaces and humidifiers	2,083,168	(NA)	(NA)
333415E	Unitary air-conditioners	6,089,160	259,614	314,530
333415F	Air source heat pumps	1,448,096	(NA)	(NA)
333415G	Ground and ground water source heat pumps	135,666	(NA)	(NA)

NA Not available. pt. Part.

1/Source: Census Bureau report EM 545, U.S. Exports (see Table 5 for a comparison of North American Industry Classification System (NAICS)-based product codes with Schedule B export codes and HTSUSA import codes.

2/Dollar value represents the c.i.f. (cost, insurance, and freight) value at the port of export.

3/Source: Census Bureau report IM 145, U.S. Imports for Consumption. Data include both import value and duty value.

4/Represents the c.i.f. (cost, insurance, and freight) value at the first port of entry in the United States plus U.S. import duties.

Table 5. Comparison of North American Industry Classification System (NAICS)-Based Product Codes with Schedule B Export Codes and HTSUSA Import Codes: 2005

Product code	Product description	Export code 1/	Import code 2/
3334151	Heat transfer equipment	8415.82.0130	8415.82.0130
		8415.82.0135	8415.82.0135
		8415.83.0140	8415.83.0140
		8418.61.0010	8418.61.0010
		8418.61.0015	8418.61.0015
		8418.61.0045	8418.61.0045
		8418.61.0050	8418.61.0050
		8418.61.0060	8418.61.0060
		8418.69.0055	8418.69.0055
3334153146	Mechanical drinking water coolers	8418.61.0020	8418.61.0020
3334155	Refrigeration condensing units	8418.99.0005	8418.99.8005
		8418.99.0010	8418.99.8010
		8418.99.0015	8418.99.8015
		8418.99.0020	8418.99.8020
		8418.99.0025	8418.99.8025
3334156	Room air-conditioners and dehumidifiers	8415.10.3040	8415.10.3040
		8415.10.3060	8415.10.3060
		8415.10.3080	8415.10.3080
		8415.82.0150	8415.82.0155
			8415.82.0160
3363917	Motor vehicle mechanical air-conditioning systems 3/	(X)	(X)
333415A	Compressors and compressor units, all refrigerants	8414.30.4000	8414.30.4000
		8414.30.8010	8414.30.8010
		8414.30.8020	8414.30.8020
		8414.30.8030	8414.30.8030
		8414.30.8050	8414.30.8050
		8414.30.8060	8414.30.8060
		8414.30.8070	8414.30.8070
		8414.30.8080	8414.30.8080
		8414.30.8090	8414.30.8090
336391B	Automotive air-conditioning compressors 3/	(X)	(X)
333415C	Nonelectric warm air furnaces and humidifiers 3/	(X)	(X)
333415E	Unitary air-conditioners (except room)	8415.81.0110	8415.81.0110
		8415.81.0120	8415.81.0120
		8415.81.0130	8415.81.0130
		8415.82.0105	8415.82.0105
		8415.82.0110	8415.82.0110
		8415.82.0115	8415.82.0115
		8415.82.0120	8415.82.0120
		8415.83.0050	8415.83.0050
		8415.83.0060	8415.83.0060
333415F	Air source heat pumps 3/	(X)	(X)
333415G	Ground and ground water source heat pumps 3/	(X)	(X)

X Not applicable

1/Source: 2005 edition, Harmonized System-based Schedule B, Statistical Classification of Domestic and Foreign Commodities Exported from the United States.

2/Source: Harmonized Tariff Schedule of the United States, Annotated (2005).

3/Import-export classification not directly comparable.

Appendix.
General CIR Survey Information, Explanation of General Terms and Historical Note

GENERAL

The CIR program has been providing monthly, quarterly, and annual measures of industrial activity for many years. Since 1904, with its cotton and fats and oils surveys, the CIR program has formed an essential part of an integrated statistical system involving the quinquennial economic census, manufacturing sector, and the annual survey of manufactures. The CIR surveys, however, provide current statistics at a more detailed product level than either of the other two statistical programs.

The primary objective of the CIR program is to produce timely, accurate data on production and shipments of selected products. The data are used to satisfy economic policy needs and for market analysis, forecasting, and decision making in the private sector. The product-level data generated by these surveys are used extensively by individual firms, trade associations, and market analysts in planning or recommending marketing and legislative strategies, particularly if their industry is significantly affected by foreign trade. Although production and shipments information are the two most common data items collected, the CIR program collects other measures also such as inventories, orders, and consumption. These surveys measure manufacturing activity in important commodity areas such as textiles and apparel, chemicals, primary metals, computer and electronic components, industrial equipment, aerospace equipment, and consumer goods.

The CIR program uses a unified data collection, processing, and publication system. The U.S. Census Bureau updates the survey panels for most reports annually and reconciles the estimates to the results of the broader-based annual survey of manufactures and the economic census, manufacturing sector. The manufacturing sector provides a complete list of all producers of the products covered by the CIR program and serves as the primary source for CIR sampling. Where a small number of producers exist, CIR surveys cover all known producers of a product. However, when the number of producers is too large, cutoff and random sampling techniques are used. Surveys are continually reviewed and modified to provide the most up-to-date information on products produced. The CIR program includes a group of mandatory and voluntary surveys. Typically the monthly and quarterly surveys are conducted on a voluntary basis. Those companies that choose not to respond to the voluntary surveys are required to submit a mandatory annual counterpart corresponding to the more frequent survey.

NORTH AMERICAN INDUSTRY CLASSIFICATION SYSTEM (NAICS), 1997

The adoption of the North American Industry Classification System (NAICS) in the 1997 Economic Census has had a major impact on the comparability of current and historic data. Approximately half of the industries in the manufacturing sector of NAICS do not have comparable industries in the Standard Industrial Classification (SIC) system that was used in the past.

While most of the change affecting the manufacturing sector was change within the sector, some industries left manufacturing and others came into manufacturing. Prominent among those that left manufacturing are logging and portions of publishing. Prominent among the industries that came into the manufacturing sector are bakeries, candy stores where candy is made on the premises, custom tailors, makers of custom draperies, and tire retreading. The net effect of the classification changes are such that if the 1997 value of shipments data for all manufacturers were tabulated on an SIC basis, it would be approximately 3 percent higher.

Listed below are the NAICS sectors:

21 Mining
22 Utilities
23 Construction
31-33 Manufacturing
42 Wholesale Trade
44-45 Retail Trade
48-49 Transportation and Warehousing
51 Information
52 Finance and Insurance
53 Real Estate and Rental and Leasing
54 Professional, Scientific, and Technical Services
55 Management of Companies and Enterprises
56 Administrative and Support and Waste Management and Remediation Services
61 Educational Services
62 Health Care and Social Assistance
71 Arts, Entertainment, and Recreation
72 Accommodation and Food Services
81 Other Services (except Public Administration)

(Not listed above are the Agriculture, Forestry, Fishing, and Hunting sector (NAICS 11), partially covered by the census of agriculture conducted by the U.S. Department of Agriculture, and the Public Administration sector (NAICS 92), covered by the census of governments conducted by the Census Bureau.)

The 20 NAICS sectors are subdivided into 96 subsectors (three-digit codes), 313 industry groups (four-digit codes), and, as implemented in the United States, 1170 industries (five- and six-digit codes).

FUNDING

The Census Bureau funds most of the surveys. However, a number of surveys are paid for either fully or partially by other Federal Government agencies or private trade associations. A few surveys are mandated, but all are authorized by Title 13 of the United States Code.

RELIABILITY OF DATA

Survey error may result from several sources including the inability to obtain information about all cases in the survey, response errors, definitional difficulties, differences in the interpretation of questions, mistakes in recording or coding the reported data, and other errors of collection, response, coverage, and estimation. These nonsampling errors also occur in complete censuses. Although no direct measurement of the biases due to these nonsampling errors has been obtained, precautionary steps were taken in all phases of the collection, processing, and tabulation of the data in an effort to minimize their influence.

A major source of bias in the published estimates is the imputing of data for nonrespondents, for late reporters, and for data that fail logic edits. Missing figures are imputed based on period-to-period movements shown by reporting firms. A figure is considered to be an impute if the value was not directly reported on the questionnaire, directly derived from other reported items, directly available from supplemental sources, or obtained from the respondent during the analytical review phase. Imputation generally is limited to a maximum of 10 percent for any one data cell. Figures with imputation rates greater than 10 percent are suppressed or footnoted. The imputation rate is not an explicit indicator of the potential error in published figures due to nonresponse, because the actual yearly movements for nonrespondents may or may not closely agree with the imputed movements. The range of difference between the actual and imputed figures is assumed to be small. The degree of uncertainty regarding the accuracy of the published data increases as the percentage of imputation increases. Figures with imputation rates above 10 percent should be used with caution.

DATA REVISIONS

Statistics for previous years may be revised as the result of corrected figures from respondents, late reports for which imputations were originally made, or other corrections. Data that have been revised by more than 5 percent from previously published data are indicated by footnotes.

DISCLOSURE

The Census Bureau collects the CIR data under the authority of Title 13, United States Code, which specifies that the information can only be used for statistical purposes and cannot be published or released in any manner that would identify a person, household, or establishment. "D" indicates that data in the cell have been suppressed to avoid disclosure of information pertaining to individual companies.

EXPLANATION OF GENERAL TERMS

Capacity. The maximum quantity of a product that can be produced in a plant in 1 day if operating for 24 hours. Includes the capacity of idle plants until the plant is reported to be destroyed, dismantled, or abandoned.

Consumption. Materials used in producing or processing a product or otherwise removing the product from the inventory.

Exports. Includes all types of products shipped to foreign countries, or to agents or exporters for reshipment to foreign countries.

Gross shipments. The quantity or value of physical shipments from domestic establishments of all products sold, transferred to other establishments of the same company, or shipped on consignment, whether for domestic or export sale or use. Shipments of products purchased for resale are omitted. Shipments of products made under toll arrangements are included.

Interplant transfers. Shipments to other domestic plants within a company for further assembly, fabrication, or manufacture.

Inventories. The quantity or value of finished goods, work in progress, and materials on hand.

Machinery in place. The number of machines of a particular type in place as of a particular date whether the machinery was used for production, prototype, or sampling, or was idle. Machinery in place includes all machinery set up in operating positions.

Net receipts. Derived by subtracting the materials held at the end of the previous month from the sum of materials used during the current month.

Production. The total volume of products produced, including: products sold; products transferred or added to inventory after adjustments for breakage, shrinkage, and obsolescence, plus any other inventory adjustment; and products that undergo further manufacture at the same establishment.

Quantities produced and consumed. Quantities of each type of product produced by a company for internal consumption within that same company.

Quantity and value of new orders. The sales value of orders received during the current reporting period for products and services to be delivered immediately or at some future date. Also represents the net sales value of contract change documents that increase or decrease the sales value of the orders to which they are related, when the parties concerned are in substantial agreement as to the amount involved. Included as orders are only those that are supported by binding legal documents such as signed contracts or letter contracts.

Quantity and value of shipments. The figures on quantity and value of shipments represent physical shipments of all products sold, transferred to other establishments of the same company, or shipped on consignment, whether for domestic or export sale. The value represents the net sales price, f.o.b. plant, to the customer or branch to which the products are shipped, net of discounts, allowances, freight charges, and returns. Shipments to a company's own branches are assigned the same value as comparable appropriate allocation of company overhead and profit. Products bought and resold without further manufacture are excluded.

Stocks. Total quantity of ending finished inventory.

Unfilled orders (backlog). Calculated by adding net new orders and subtracting net sales from the backlog at the end of the preceding year.

HISTORICAL NOTE

Data on air-conditioning and refrigeration have been collected by the Census Bureau since 1944. Historical data may be obtained from Current Industrial Reports (called Facts for Industry before 1959) available at your local Federal Depository Library.

AHRI Proposal for Embedded Fans in Commercial HVACR and Water Heating Equipment

Discussion with the California Energy Commission

Tuesday, November 28, 2017

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Overview of AHRI Proposal

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Fan Overview

Embedded Fan Definitions

- Embedded Fan: A fan included as a component in a residential, commercial, or industrial heating, ventilation, air-conditioning (HVACR) or water heating equipment where the fan is:
  - Permanently mounted in the equipment
  - Used to support heat transfer, combustion or other mechanisms within the equipment
  - Tested as part of equipment certification according to ANSI, ASHRAE, AHRI, DOE or other performance standards; and labeled for such use if sold as a fan assembly only for use within an exempt product.
- Replacement Embedded Fan:
  - An impeller, blade or wheel sold without a motor, with or without shaft and bearings, designed and marketed as a replacement for an existing part in an Embedded Fan, including cross-reference(s) to the original fan part and a label stating that this part is for replacement purposes only.
  - Complete Embedded Fan assemblies including cross-reference(s) to the original blower part and a label stating that this part is for replacement purposes only.

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AHRI Recommendation

Proposal and Rationale

Proposal

- Limit scope of proposed regulations on commercial and industrial fans to stand-alone fans only
- Exclude all fans embedded in HVACR and water heating equipment
  - Fans embedded in equipment
  - Replacement embedded fans

Rationale

- Vast majority of embedded fans already covered by California and Federal standards
- Very little energy can be saved through additional standards
- As with most component regulations, no overall energy savings at product level as other components are modified such that overall efficiency meets market requirements
- Costs will increase to consumers due to fan development and equipment testing and certification requirements
  - Small shipment volumes of products potentially affected by commercial and industrial fan standards raise effective cost per fan
- Like-for-like replacement fan components critical for repairs on existing HVACR equipment

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AHRI Recommendation

Embedded Fans Already Covered by California Standards

Product	Fan Application	Standard Coverage
Commercial Unitary Air Conditioner and Heat Pump	Panel	
	Supply	
	Exhaust	
Central Station Air Handling Unit	Supply, Exhaust	
Air Cooled Chiller	Panel	

Federal Standard, CA Title 20, CA Title 24, 110.2 (b)

CA Equipment Limit, Title 24, 110.2 (d and g)

CA Fan Limit, Title 24, 140.4 (c), 140.9 (a - 4 and 5)

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AHRI Methodology Summary

Changes to DOE NODA 3 Analysis

- National Impact Analysis:
  - Changes in Base Case Shipments
    - Air-Cooled Chillers
    - Central Station Air-handling Units
    - Commercial Unitary Packaged Air-conditioners and Heat Pumps
  - Life Cycle Cost Inputs
    - LCC Input sheet in NIA did not correspond to DOE NODA 3 spreadsheet. AHRI modified to "OEM, Reference" from the "LCC Results" sheet of the LCC model to reflect that all analyzed Panel Fans are used in OEM applications
    - CA adjustment: 12% of national market seems reasonable
- Life Cycle Cost:
  - Equipment Costs
    - AMCA database does not adequately capture OEM fans market. Should not be used as a proxy for annual shipments
    - Total industry costs not volume dependent
    - Lead to updated OEM panel, unhoused centrifugal and house centrifugal numbers
  - CA Electric Rates and TDV
    - AHRI has updated the DOE analysis of estimated end user economics based on:
      - Average California May 2017 commercial electricity prices of $0.1438 per kWh.
      - 20% increase in average California commercial electricity prices to approximate possible TDV pricing

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Potential Energy Savings – Total U.S.

DOE Analysis Leaves Inaccurate Perception of Energy Saving Potential

Category	Total US 30 Year Quads	
HVACR + WH Categories		
Panel	0.60	
Housed Centrifugal	1.59	
Unhoused Centrifugal	0.76	
Sub-Total		2.95
Other		4.28
Total Fans		7.23

Source: DOE cif_noda3_nia.xlsm

DOE projected savings *not* corrected for embedded fan percentages.

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Potential Energy Savings – Total U.S

Actual Potential Savings Much Less

Category	Total US 30 Year Quads - DOE	Total US US 30 Year Quads - AHRI
Embedded HVACR + WH		
Panel	0.60	0.00
Housed Centrifugal	1.59	0.20
Unhoused Centrifugal	0.76	0.13
Total Embedded	2.95	0.33

Source: DOE cif_noda3_nia.xlsm, AHRI analysis

AHRI projected savings are due to equipment standards only and exclude potential effects of building standards.

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Potential Energy Savings - California

Actual Potential Savings Much Less (Continued)

Category	California 30 Year Quads - DOE	California 30 Year Quads - AHRI
Embedded HVACR + WH		
Panel	0.072	**0.000**
Housed Centrifugal	0.191	**0.024**
Unhoused Centrifugal	0.091	**0.016**
Total Embedded	0.354	**0.040**

Source: DOE cif_noda3_nia.xlsm, AHRI analysis 12% California factor

AHRI projected savings are *before* effects from CA Title 24 building fan limits.
After building fan limits, likely savings approach zero.

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Embedded Fan Overview

Centrifugal Fans

Panel Fans

Commercial Water Heating and Boiler Fans

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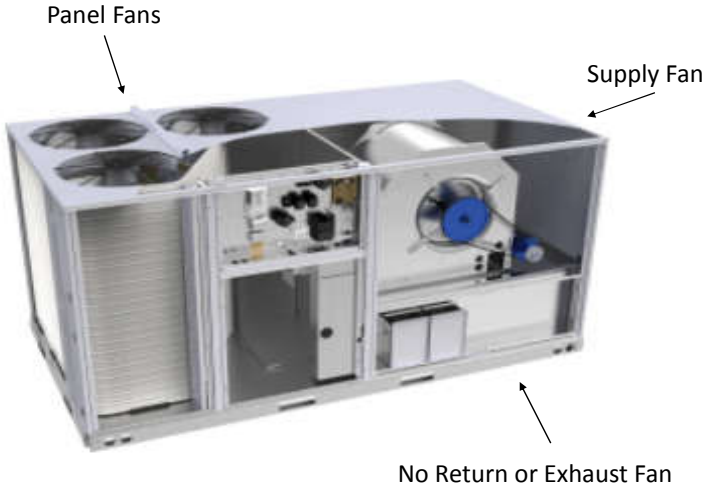
Centrifugal Fans

Embedded Fan Examples – Simple Rooftop Unit (~90% of Market)



Source: Carrier Corporation

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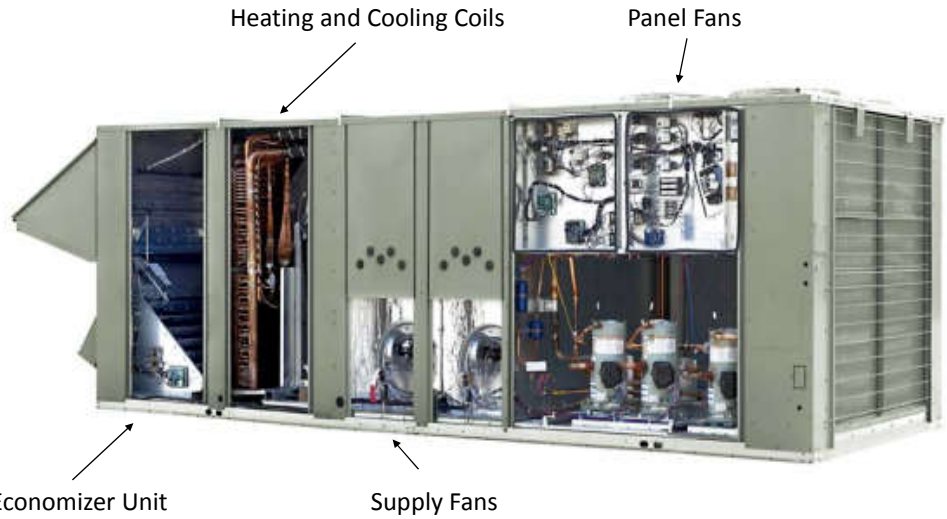
Centrifugal Fans

Embedded Fan Examples – Large Rooftop Unit (~10% of Market)



Source: Ingersoll Rand, Inc.

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Centrifugal Fans

Embedded Fan Examples – Central Station Air Handling Unit

Source: Dunham-Bush Americas

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Centrifugal Fans

Corrections to the Analysis

- Incorrect shipment data
  - Overstated central station air handling unit shipments
  - Overstated percentage of commercial unitary units with return/exhaust fans
    - Exhaust/return air fans used with economizers common in large/complex rooftop units and rare in small ones
- No consideration for existing Title 24 fan power limits
  - DOE analyses are national and generally exclude building code effects
- Insufficient consideration of speed control for supply fan motors
  - Now common in central station air handling units and large commercial unitary rooftops
  - Required under CA Title 24 140.4(m) and 140.9, (a - 5)
  - Results in significant reduction in fan motor power vs systems with a single speed fan
- No consideration of market forces for fans not covered by prescriptive standards
  - Design reviews required in CA
  - Building process for large rooftop and central station air handlers promotes cost/energy use analysis in designs

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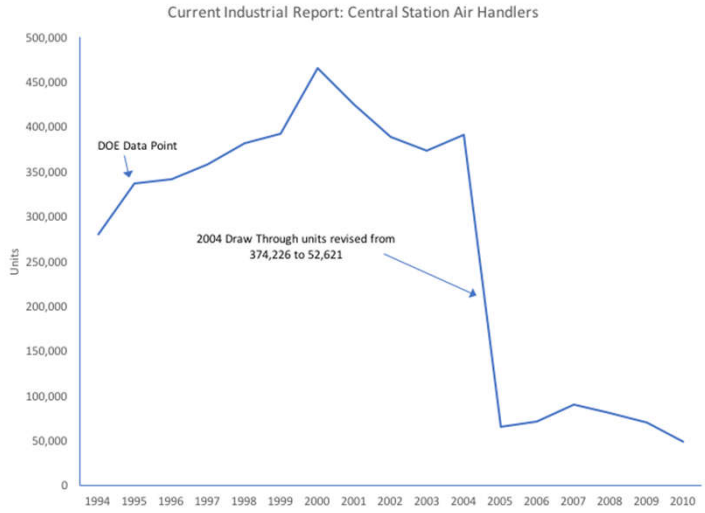
Centrifugal Fans

DOE Relied on Incorrect Data from Current Industrial Report



Source: US Department of Commerce, Current Industrial Report MA35M and MA333M

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Centrifugal Fans

Projected 30 Year Energy Savings (Quads)

Fan Type	Corrected Savings	Embedded %	Embedded Savings - US	Embedded Savings - CA
Centrifugal Housed	0.39	51%	0.20	0.024
Centrifugal Unhoused	0.21	64%	0.13	0.016
Total	0.60	55%	0.33	0.040

Corrected for shipment data only, does not include effects of Title 24 or other building standards or of variable speed drives.

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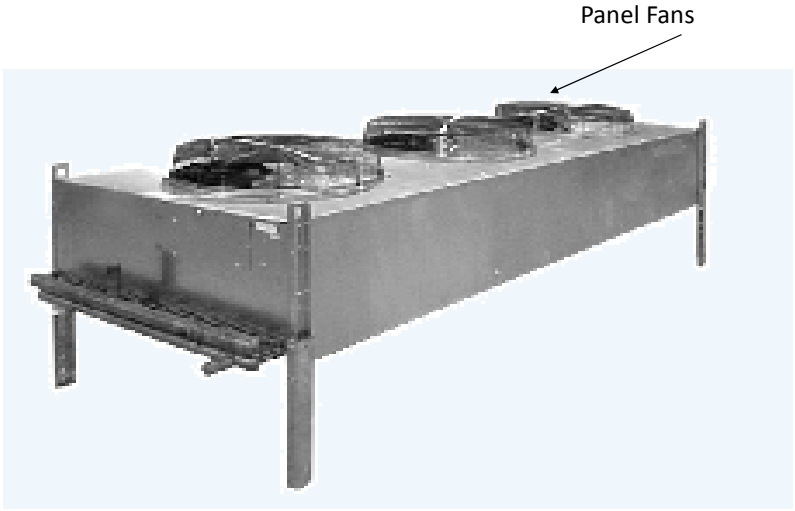
Panel Fans

Embedded Fan Examples – Remote Condenser, Refrigeration



Source: Heatcraft Worldwide Refrigeration

Panel Fans

Embedded Fan Examples – Air-Cooled Chiller

Source: Carrier Corporation

Panel Fans

Corrections to the Analysis

- Incorrect product characterization
  - DOE analysis assumes Air Cooled Chillers are independent products
  - Virtually all are integrated with compressor units and all meet ASHRAE 90.1 chiller standards and Title 24, Table 110.2-D
  - Remote air cooled condensing units common in commercial refrigeration (covered by Title 24, Table 120.6-C), not in air conditioning for mild climates
  - Changing fans will result in rebalancing product design, not energy savings
- Incorrect, offsetting shipment data
  - Overstates average number of fans per condensing unit (14 vs. 8 estimated by manufacturers). DOE fan estimates equivalent to 200 tons, overstates average size of air-cooled chillers.
  - DOE underestimates number of chillers (12,579 vs. CIR average of 26,000)
- Incorrect energy usage
  - DOE uses *average* energy consumption and cost, not *OEM*,
    - 50% less energy used by OEM panel fans
    - 30% lower savings at EL 5 (5.4% vs 7.6%)

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Panel Fans

Projected 30 Year Energy Savings (Quads)

Fan Type	Corrected Savings	Embedded HVAC %	Embedded Savings - US	Embedded Savings - CA
Total	0.1	65%	0.065	0.008

Corrected for shipment and OEM Fan Usage data only, does not include effects of Title 24 integrated chiller standards or other building standards or of variable speed motors requirements.

Total actual savings likely to be 0 quads.

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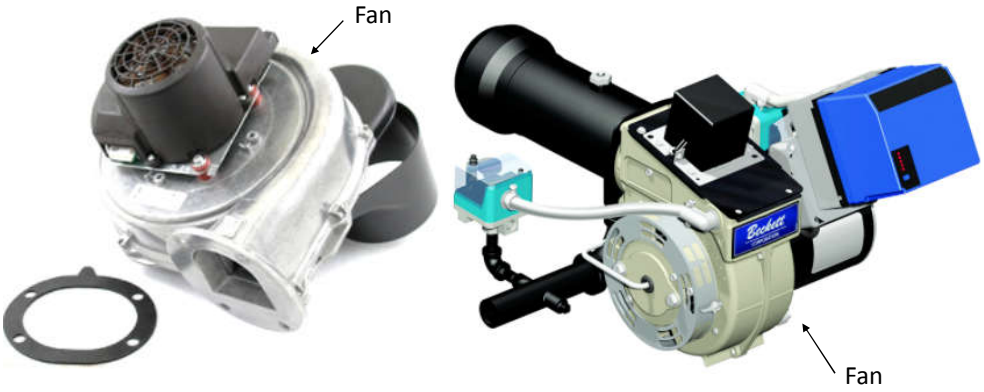
Fan Overview

Embedded Fan Examples – Commercial Boiler Fan Assembly



Source: Lochinvar, LLC, Beckett Corporation, images not to same scale

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Commercial Water Heating and Boiler Fans

Virtually No Fans over 1HP

- Fan energy included in commercial water heater standards
- Fan energy not included in commercial boiler or commercial water supply boiler standards
- Extremely limited savings opportunity
  - Small markets
  - Few fans over 1HP
  - Fans integral to product designs, difficult to replace or redesign
  - Replacing embedded fans would require complete retesting and recertification for safety and other purposes

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Consumer Economics

Consumer Economics

Overview

- Consumer economics based on DOE LCC model from fan rulemaking.
- Absence of detailed data for individual Monte Carlo tests makes analysis difficult, so conclusions should be taken with caution. However, **no other data exists.**
- All but one DOE assumption accepted despite vehement industry protests:
  - Ability to substitute fan with 2" increase in diameter without any increase in cost to total package
  - No accounting for extra curb of duct changes in replacement scenarios if exterior dimensions of outside equipment change
  - Probable under-estimation of conversion costs
    - Additional refrigeration cycle, heating, performance, acoustical, safety, and seismic testing
    - Engineering to accommodate larger fans
  - Discrepancy between discount rates in LCC analysis and in conversion cost annualization
  - DOE incremental markups
- Conversion costs adjusted for actual shipment volumes, not fans in AMCA database.

Consumer Economics

Centrifugal Fans

Housed OEM Centrifugal Fans (per fan)	DOE Estimates
Incremental Consumer Price	$291
Lifetime Operating Cost Savings	$606
Life Cycle Cost Savings	$315
Conversion Costs Adjusted for Shipments[1]	$336
Adjusted Life Cycle Cost Savings	($21)

- Assumes energy savings from fan. No actual savings in most instances:
  - No savings in supply or panel fans in new unitary equipment or chillers due to equipment efficiency standards
  - No savings for any fan in new construction
  - Repair fans in practice must be OEM original equipment for testing, safety or physical reasons
- Without savings, consumer change in LCC would be ($627) or 29% price increase

[1] Based on national shipments, *CA only would vastly increase costs*

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Consumer Economics

Panel Fans

Housed OEM Panel Fans (per fan)	DOE Estimates
Incremental Consumer Price	$106
Lifetime Operating Cost Savings	$228
Life Cycle Cost Savings	$122
Conversion Costs Adjusted for Shipments[1]	$122
Adjusted Life Cycle Cost Savings	($0)

- Assumes energy savings from fan. No actual savings in most instances:
  - No savings in panel fans in new unitary equipment or chillers due to equipment efficiency standards
- Repair fans in practice must be OEM original equipment for testing, equipment performance or physical reasons
- Without savings, consumer change in LCC would be ($228) or 14% price increase

[1] Based on national shipments, *CA only would vastly increase costs*

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Thank you!

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AHRI Presentation

California Energy Commission Staff Workshop – Commercial and Industrial Fans and Blowers, Docket 17-AAER-06

Wednesday, July 11, 2018

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Regulated Products Should be Exempt

DOE and CEC Existing Product Regulations

- All fans in all federally regulated products are preempted
  - ASRAC Working Group and CEC Draft Staff Report lists are incomplete
    - Transport refrigeration fans that can be plugged into the grid should be included to align with ASRAC
    - Small commercial split system air-conditioning and heating equipment (10 CFR 431.92) with cooling capacity less than 65,000 Btu/h.
    - Hydronic heating and burner fans – no analysis and different functions
    - Refrigeration systems (Standard 1250/DOE 10 CFR Part 431) including, unit coolers, condensing units, and single package refrigeration units
- Fans regulated by California for overall performance should be exempt
  - Unitary Large Equipment over 760,000 Btu/h
  - Commercial split condensing units (over 240k Btu/h)
  - Air-cooled chillers
  - AHU (BHP/CFM)
- Economizer fans
- Heat rejection fans need to be defined - AHRI supports CTI definition
- Replacement fans

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CEC Should not Depend on Flawed, Incomplete DOE Analysis

NODA3 Requires Corrections

- Completed prior to ASRAC WG Term Sheet – needs to be revised
- Major errors are:
  - Air handler annual sales
  - Percent estimated return air fans and exhaust air fans on unitary equipment
  - Number of air-cooled chillers condenser fan per unit
  - Understated development costs
    - DOE's analysis is based on the upper left-hand portion of the performance, this is not where systems operate
    - DOE's assumption that 2" more will fit is false
    - Consequential costs = larger cabinet, acoustics, seismic, wind, heat safety, DX performance, and embedded fan performance

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AHRI has Submitted Corrections to DOE NODA3

CEC Needs to Update the Analysis per AHRI Proposal

- National Impact Analysis:
  - Changes in Base Case Shipments
    - Air-Cooled Chillers
    - Central Station Air-handling Units
    - Commercial Unitary Packaged Air-conditioners and Heat Pumps
  - Life Cycle Cost Inputs
    - LCC Input sheet in NIA did not correspond to DOE NODA 3 spreadsheet. AHRI modified to "OEM, Reference" from the "LCC Results" sheet of the LCC model to reflect that all analyzed Panel Fans are used in OEM applications
    - CA adjustment: 12% of national market seems reasonable
- Life Cycle Cost:
  - Equipment Costs
    - AMCA database does not adequately capture OEM fans market. Should not be used as a proxy for annual shipments
    - Total industry costs not volume dependent
    - Lead to updated OEM panel, unhoused centrifugal and house centrifugal numbers
  - CA Electric Rates and TDV
    - AHRI has updated the DOE analysis of estimated end user economics based on:
      - Average California May 2017 commercial electricity prices of $0.1438 per kWh.
      - 20% increase in average California commercial electricity prices to approximate possible TDV pricing

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Centrifugal Fans

Corrections to the Analysis

- Incorrect shipment data
  - Overstated central station air handling unit shipments
  - Overstated percentage of commercial unitary units with return/exhaust fans
    - Exhaust/return air fans used with economizers common in large/complex rooftop units and rare in small ones
- No consideration for existing Title 24 fan power limits
  - DOE analyses are national and generally exclude building code effects
- Insufficient consideration of speed control for supply fan motors
  - Now common in central station air handling units and large commercial unitary rooftops
  - Required under CA Title 24 140.4(m) and 140.9, (a - 5)
  - Results in significant reduction in fan motor power vs systems with a single speed fan
- No consideration of market forces for fans not covered by prescriptive standards
  - Design reviews required in CA
  - Building process for large rooftop and central station air handlers promotes cost/energy use analysis in designs

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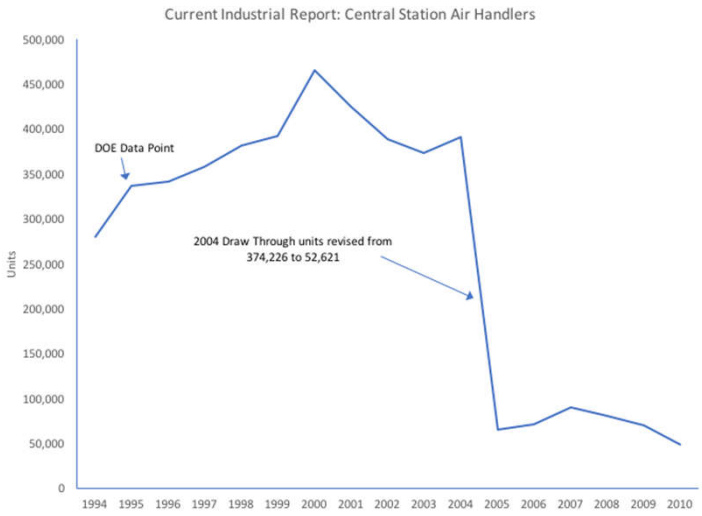
Centrifugal Fans

DOE Relied on Incorrect Data from Current Industrial Report



Source: US Department of Commerce, Current Industrial Report MA35M and MA333M

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Panel Fans

Corrections to the Analysis

- Incorrect product characterization
  - DOE analysis assumes Air Cooled Chillers are independent products
  - Virtually all are integrated with compressor units and all meet ASHRAE 90.1 chiller standards and Title 24, Table 110.2-D
  - Remote air cooled condensing units common in commercial refrigeration (covered by Title 24, Table 120.6-C), not in air conditioning for mild climates
  - Changing fans will result in rebalancing product design, not energy savings
- Incorrect, offsetting shipment data
  - Overstates average number of fans per condensing unit (14 vs. 8 estimated by manufacturers). DOE fan estimates equivalent to 200 tons, overstates average size of air-cooled chillers.
  - DOE underestimates number of chillers (12,579 vs. CIR average of 26,000)
- Incorrect energy usage
  - DOE uses *average* energy consumption and cost, not *OEM*,
    - 50% less energy used by OEM panel fans
    - 30% lower savings at EL 5 (5.4% vs 7.6%)

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Commercial Water Heating and Boiler Fans

Virtually No Fans over 1HP

- Fan energy included in commercial water heater standards
- Fan energy not included in commercial boiler or commercial water supply boiler standards
- Extremely limited savings opportunity
  - Small markets
  - Few fans over 1HP
  - Fans integral to product designs, difficult to replace or redesign
  - Replacing embedded fans would require complete retesting and recertification for safety and other purposes

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Potential Energy Savings – Total U.S.

DOE Analysis Leaves Inaccurate Perception of Energy Saving Potential

Category	Total US 30 Year Quads	
HVACR + WH Categories		
Panel	0.60	
Housed Centrifugal	1.59	
Unhoused Centrifugal	0.76	
Sub-Total		2.95
Other		4.28
Total Fans		7.23

Source: DOE cif_noda3_nia.xlsm

DOE projected savings *not* corrected for embedded fan percentages.

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Consumer Economics

Overview

- Consumer economics based on DOE LCC model from fan rulemaking.
- Absence of detailed data for individual Monte Carlo tests makes analysis difficult, so conclusions should be taken with caution. However, **no other data exists.**
- All but one DOE assumption accepted despite vehement industry protests:
  - Ability to substitute fan with 2" increase in diameter without any increase in cost to total package
  - No accounting for extra curb of duct changes in replacement scenarios if exterior dimensions of outside equipment change
  - Probable under-estimation of conversion costs
    - Additional refrigeration cycle, heating, performance, acoustical, safety, and seismic testing
    - Engineering to accommodate larger fans
  - Discrepancy between discount rates in LCC analysis and in conversion cost annualization
  - DOE incremental markups
- Conversion costs adjusted for actual shipment volumes, not fans in AMCA database.

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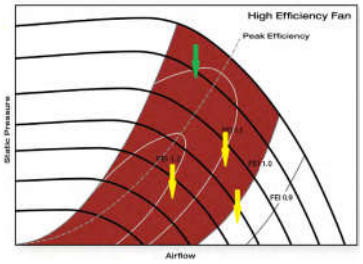
The FEI Paradox

Other energy savings measures reduce FEI

There are three ways to reduce fan energy consumption:

1. Use a more efficient fan, transmission, motor and/or controller
2. Make the system true variable volume airflow.
3. Reduce the pressure required to circulate air.
   - Larger ducts
   - Larger components – coils, filter face area, etc.

- Only #1 yields improved FEI.
- Add a variable speed drive (#2), and wire-to-air efficiency drops, yielding a lower FEI.
- Reducing pressure drop for a given fan system usually reduces FEI. See the illustration at right and on the next page.



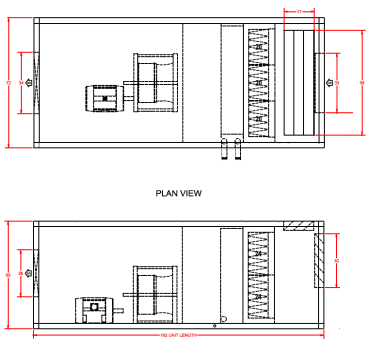
Each arrow represents a change in system design where the airflow and fan remain the same, but flow resistance is reduced.

- Only when the original fan selection is to the left of the peak, which is rare, does FEI go up.
- For the vast majority of selections, it goes down.

The FEI Paradox

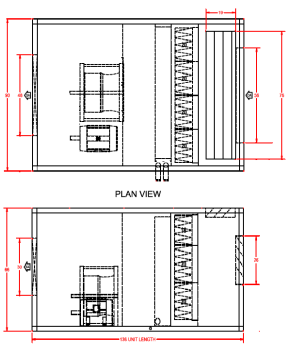
Lower AHU power consumption yields lower FEI

Unit A



Fan Static Pressure Rise: 4.35 in. H_2O
Fan Brake Horsepower: 12.88 HP
FEI: 1.17

Unit B



Fan Static Pressure Rise: 2.46 in. H_2O
Fan Brake Horsepower: 8.44 HP
FEI: 1.09

FEP calculated per AMCA 208 section 5.3.2

Two air handlers, with identical fans, motors and transmissions

Each has identical performance except for the fan brake horsepower at the design point:

- 12,000 SCFM
- 80°F db / 67°F db mixed air entering the coil
- 53°F db / 52.9°F db leaving the coil
- MERV-8 pre-filter
- MERV-13 high-efficiency filter
- 24.5" v-belt drive plenum fan
- 15 HP NEMA General Purpose Motor
- Rated with 1.0" external static pressure

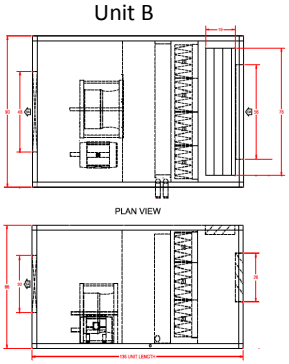
The difference: Unit B has:

- A larger cabinet
- Larger coil and filter face areas
- Larger entrance and exit openings

The FEI Paradox

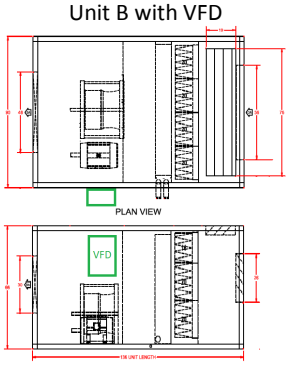
A Variable Speed Drive is more efficient?

Unit B



Fan Static Pressure Rise: 2.46 in. H_2O
Fan Brake Horsepower: 8.44 HP
FEI: 1.09

Unit B with VFD



Fan Static Pressure Rise: 2.46 in. H_2O
Fan Brake Horsepower: 8.44 HP
FEI: 1.04

Adding a variable speed drive to a system, along with actually varying the airflow in operation is one of the best ways to save fan energy.

The units shown here are Unit B from the previous slide and the identical unit with a VFD.

FEP calculated per AMCA 208 section 5.3.2

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The FEI Paradox

How do we account for it in an appliance code?

- Clearly, there is no intention that the code discourage the design of more efficient systems. Here are some options to consider:
- For fans sold with variable speed drive, allow a lower FEI as long as the fan system will truly be operated as variable flow.
  - Proposed language:
  - (3) Commercial and Industrial Fans and Blowers. The FEI of commercial and industrial fans and blowers manufactured on or after January 1, 2020, shall be at least 1.0 or higher. If the fan system is to be operated as a variable flow system meeting the requirements of Title 24 Section 140.4.c.2.b and c then the FEI shall be 0.95 or higher.
- The difference in fan pressure rise is tougher to tackle. It must be made clear to consumers that a higher FEI does not necessarily result in energy savings when two fans not operating at the same duty point are compared.

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The FEI Paradox

How do we account for it in an appliance code?

- The difference in fan pressure rise is tougher to tackle. It must be made clear to consumers that a higher FEI does not necessarily result in energy savings when two fans not operating at the same duty point are compared.
- Some options:
- Clarify this in the definition of FEI:
  - "Fan Energy Index or FEI" means the ratio of a reference fan electrical input power over actual fan electrical input power at a single airflow and pressure rise as calculated under the test method in Section 1604(d). FEI shall not to be used to compare the energy efficiency of fans operating at different duty points nor the energy efficiency of fans embedded in different models of equipment where the pressure drop of the equipment is not known.
- For fans and embedded equipment with known duty points, require that FEI (calculated per AMCA 207 or tested) be included on the label.

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Labeling & Reporting

Issues When Applied to Embedded Fans

- Labeling & reporting
  - Application design point requirements
  - Stock unit issues
  - Fan serial numbers don't always exist
  - BMGs and implications unclear especially on engineered products
  - If required, must be based on Standard air or density
- Implementation
  - Need more time to comment – 60-day request for extension submitted
  - Need more time to comply – consequential development already mentioned

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Enforcement Issues

Issues When Applied to Embedded Fans

- Manufacturers often do not know design conditions and can never verify them
- Designers / owners can change a non-compliant selection to compliant by artificially increasing total static pressure
- Field modifications are often needed and untraceable
- Embedded fan performance in published literature cannot be compared to stand-alone performance
- Draft staff report silent on fans that cannot be tested outside the equipment

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Questions?

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