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Response to Invitation to Participate - Fans and Blowers

Additional submitted attachment is included below.

Fans & Blowers

Codes and Standards Enhancement (CASE) Initiative
For PY 2017: Title 20 Standards Development

Response to the California Energy Commission's Invitation to Participate
Phase 2 Pre-Rulemaking
Fans and Blowers
17-AAER-06

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF EQUATIONS

1. Executive Summary

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (Energy Commission) efforts to update California's Appliance Efficiency Regulations (Title 20) to include new requirements for commercial and industrial fans and blowers. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE), and SoCalGas® – sponsored this effort (herein referred to as the Statewide CASE Team). The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve the energy and water efficiency of various products sold in California. The information presented herein is a response to the Energy Commission's Invitation to Participate Phase 2 Pre-Rulemaking for Commercial and Industrial Fans and Blowers.

The most important current development for fans and blowers is the ongoing Air Movement and Control Association (AMCA) Standard 208 development. As of early June, the committee expects the standard to be ready by the end of 2017, at the latest. This standard will describe the Fan Efficiency Index (FEI) metric that industry and efficiency advocates have coalesced behind as the preferred regulated metric. Section 8.1 will further explain the history of fan metrics used and why FEI is now the preferred metric. AMCA 208 could serve as an effective blueprint that the Energy Commission can use for its test procedure and analysis of potential standard levels. Additionally, AMCA Standard 211 may revise the requirements in regards to FEI ratings as part of AMCA's Certified Ratings Program. Historically, AMCA 211 has addressed fan efficiency labeling and may be modified in the future to address FEI. CEC will be able to leverage AMCA 208 in the development of potential test procedures and efficiency levels.

DOE's rulemaking process for fans and blowers has been ongoing for several years and the rulemaking docket[1] includes the term sheet from the ASRAC stakeholder Working Group, which outlines the items for which consensus was reached between manufacturers and efficiency advocates, as well as DOE's economic and engineering analysis results. Overall, the Statewide CASE Team recommends that the Energy Commission adhere to the scope of equipment and other details in the term sheet as much as possible. While we understand the Energy Commission may be interested in expanding the scope to capture more energy savings, the Statewide CASE Team cautions that the existing scope is the result of years of negotiation with industry. One exception the Statewide CASE Team recommends with regards to the term sheet is that the Energy Commission base any efficiency standard off the FEI rating, rather than the Fan Electrical Power (FEP) rating, which is used in DOE's most recent NODA. The differences between these two metrics are minor and will be further explained in Section 8.1 of this document.

A fans and blowers standard has the potential to generate significant energy savings. The Statewide CASE Team is supportive of this topic's inclusion in the Phase 2 pre-rulemaking and is eager to work with the Energy Commission and other stakeholders to identify appropriate standard levels that will result in significant cost-effective savings. Furthermore, a standard would be transformational in the sense that stakeholders will be able to understand the relative efficiency of fan selections in catalogs and selection software for the first time.

[1] https://www.regulations.gov/docket?D=EERE-2013-BT-STD-0006

2. Overview

There are currently no efficiency standards for commercial and industrial fans and blowers at the state or federal level.

The Statewide CASE Team remains supportive of the ASRAC adopted 2015 final term sheet developed by efficiency advocates and manufacturers and believe this term sheet provides a good starting point for CEC as Title 20 standards for fans are considered. Most importantly, the Statewide CASE Team recommends that the Energy Commission adhere to the fan size (fan shaft power greater than or equal to 1 hp, and air power less than or equal to 150 hp) and the scope (fan categories included and excluded and treatment of embedded fans) outlined in the term sheet (Note that the scope is further outlined in Section 4). DOE spent years studying this product class and released three Notices of Data Availability (NODA) between 2014 and 2016. There was also an Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) negotiation that took place over the course of several months in 2015 and the IOUs participating in this Working Group. We understand ASHRAE has also been briefed on these developments and is considering pursuing FEI in its future code updates. These previous efforts provide a strong starting point to complete a Title 20 rulemaking for fans and blowers.

Engineers and other individuals who select fans tend to choose operating points to the bottom right of the fan performance map, which is distant from the peak efficiency. This selection practice typically leads to inefficient fans that minimize first cost. The intention of a standard would be for fans to be selected closer to peak efficiency region. Please refer to Figure 1 for an illustration of a typical forward curved fan curve.

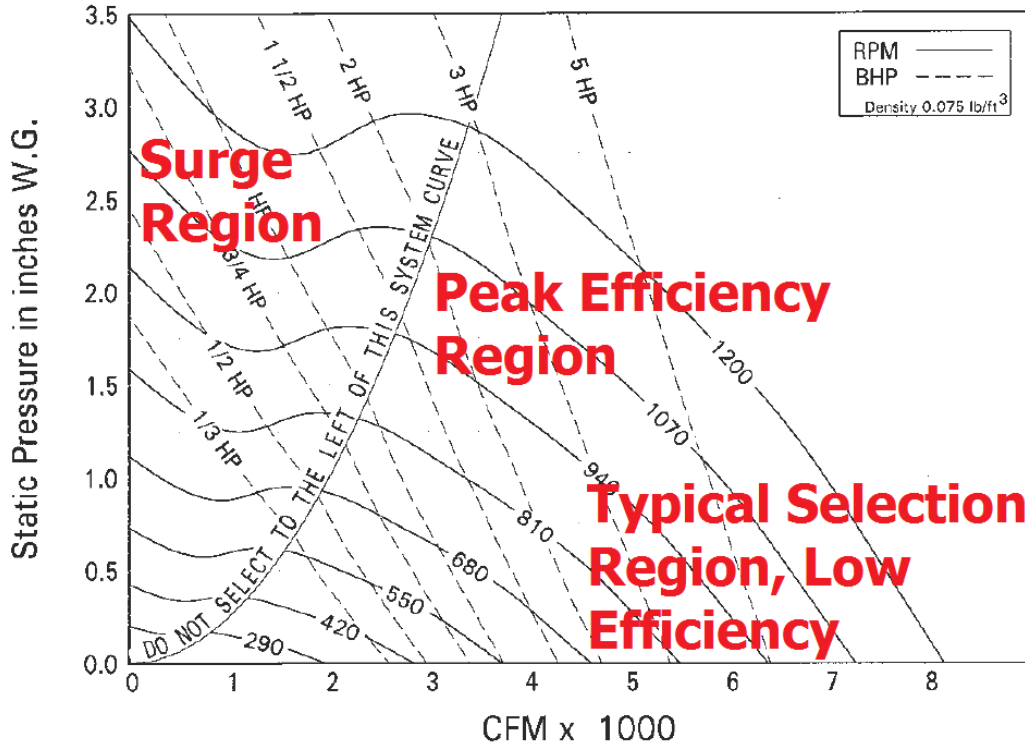

Figure 1: Fan curve for a forward curved blower

The Statewide CASE Team encourages regulating fans using FEI, which is the ratio of the power consumption of a minimally compliant fan to the power consumption of a given fan (meaning that a higher FEI signifies a more efficient fan).[2] This ratio would be calculated across the entire fan operating range (all pressure and airflow points). The outcome would be an allowable region of operating points within the performance map. A standard of this nature would shift fan selections to models that consume less power at a specific design point.

3. Background

3.1 Regulatory Background

3.1.1 Federal Regulatory Background

In Section 1 "History of Energy Conservation Standards Rulemaking for Commercial and Industrial Fans and Blowers" of DOE's November 1, 2016 NODA,[3] DOE describes the history of its fans and blowers rulemaking in detail. In summary, the initial action began in June 2011, when DOE published a notice of proposed determination of coverage.[4] The latest action from DOE was the aforementioned November 1, 2016 NODA (III). It should be noted that DOE has never published a final determination of coverage, so there are no preemption concerns with California initiating a rulemaking for fans and blowers.

[2] https://www.amca.org/resources/documents/Introducing%20the%20Fan%20Energy%20Index%20Metric.pdf
[3] 81 FR 26341
[4] 76 FR 37678

3.1.2 California Regulatory Background

There are currently no Title 20 regulations for commercial and industrial fans and blowers. However, as mentioned previously, there are building code commercial fan power limitations in Title 24. The fan power limitations are currently being revisited and updated to align with ASHRAE 90.1 as part of the Title 24-2019 code development process.

3.2 Utility and Other Incentive Programs

The IOUs do not currently run any incentive programs for commercial and industrial fans and blowers. However, the FEI metric is well suited to be used by utilities to develop incentive programs. For example, if the minimum standard was an FEI of 1.0, a utility program could offer rebates for fans that provide an FEI of 1.1 or greater at the customer's design point. In theory, a fan with an FEI of 1.1 would be 10% more efficient than a fan with an FEI of 1.0. We believe there are significant opportunities for utility incentive programs using the FEI framework.

3.3 Model Codes and Voluntary Standards

Currently there are model codes and voluntary standards that use Fan Efficiency Grade (FEG) as the regulated metric (please refer to Section 8.1 for a detailed discussion on fan efficiency metrics). ASHRAE 90.1 contains a FEG requirement of 67 or greater, and that fans operate within 15 percent total efficiency of its peak efficiency at the specified design point[5]. The International Green Construction Code (IGCC) has set a stretch code of 71 FEG minimum, and that fans operate within a 10 percent window from peak efficiency. It should be noted that FEG is not currently adopted within the California Title 24 building code.

4. Product Description

Fans are used to move air. Fans are essential to building Heating, Ventilation, and Air Conditioning (HVAC) systems and are frequently needed for various industrial applications.

There are several types of fans that are commonly encountered in commercial and industrial settings. The stakeholder Working Group term sheet recommended the following types of fans for coverage as part of any eventual efficiency standards:[6] (1) axial cylindrical housed; (2) panel; (3) centrifugal housed, excluding inline and radial; (4) centrifugal unhoused, excluding inline and radial; (5) inline and mixed-flow; (6) radial housed; and (7) power roof ventilators. The term sheet also recommended excluding the following fan types: (1) radial housed unshrouded fans with diameter less than 30 inches or a blade width of less than 3 inches; (2) safety fans; (3) circulating fans; (4) induced flow fans; (5) jet fans; and (6) cross flow fans. Additionally, the term sheet outlined in Recommendations #2, #3 and #4, the various conditions for which fans in embedded equipment would be included or excluded.

Centrifugal fans (blowers) move air radial relative to the fan shaft orientation. Axial fans move air parallel to the fan shaft. In mixed-flow fans, airflow is a mix between radial and parallel to the fan shaft. Centrifugal fans can have forward curved, backward inclined, or airfoil-type blades. Fans can be housed or unhoused.

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[5] ASHRAE 90.1-2016, section 6.5.3.1.3 Fan Efficiency

[6] Term Sheet

4.1 Fan Definitions

The Statewide CASE Team would like to highlight that while specific definitions of fans have been discussed extensively throughout the DOE rulemaking process and stakeholder Working Group, no final definitions were proposed or included in any of the NODA documents or the September 3, 2015 final term sheet. However, working fan definitions were included in an Appendix D of the August 17, 2015 interim term sheet. We encourage CEC to use these definitions as a starting point, while also acknowledging that work may remain to finalize these definitions.[7]

5. Market Analysis

The third DOE NODA includes a "National Impact Analysis" spreadsheet[8] which contains national shipments data by fan type. This analysis is mainly based on AMCA provided shipment data, though other sources are described in the spreadsheet.

5.1 Market Share of Qualifying Products

5.1.1 Current Market Share

Because a formal standard level has yet to be proposed, it is unknown how fan selections would comply. DOE's recent NODA analysis includes various efficiency levels, which would result in varying levels of existing fan selections complying. DOE's most stringent efficiency level, EL 6, would eliminate 70 percent of the allowable fan *selections*. However, this does not necessarily mean that the fans themselves need to be redesigned; instead, the number of allowable selections (at different pressures and flows) of the fan would be limited. DOE estimates that more than half of these non-compliant fan selections could be met with existing substitutes currently available in the market, which means that about 33 percent of fans would require a redesign at EL 6.

5.1.2 Future Market Adoption of Qualifying Products

As discussed elsewhere in this document, a potential standard will change the fan operating points which are allowed to be marketed (for example in fan catalogs and in selection software made available by manufacturers). By providing a signal to designers in the form of allowable operating points, low efficiency selections will be disallowed and fan operating points will be chosen closer to the peak efficiency for any given fan.

6. Test Methods

6.1 Current Test Methods

Fans are currently rated using the FEG metric, as described in AMCA 205. AMCA 205 was initially published in 2010.[9] Another standard of importance is AMCA 210, which establishes uniform test methods for a laboratory test of a fan to determine its aerodynamic performance in terms of airflow rate, pressure developed, power consumption, air density, speed of rotation, and efficiency for rating or guarantee purposes.

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[7] https://www.regulations.gov/contentStreamer?documentId=EERE-2013-BT-STD-0006-0143&attachmentNumber=1&contentType=pdf
[8] https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0192
[9] http://www.amca.org/UserFiles/file/024-031_cermak_WEB.pdf

FEG is problematic because it is an indicator of fan peak total efficiency, not input power. Because the metric does not distinguish between fan types, fan types that may be ideal for certain applications for reasons other than energy efficiency would be prevented from being used due to a low FEG rating. FEG is also limited by fan type and horsepower. The shortcomings of FEG are significant enough such that there is widespread recognition that it should be replaced by a metric accounting for input power going forward.

6.2 Potential Test Methods

AMCA is in the final stages of completing its Standard 208 which will allow manufacturers to test and rate fans using the FEI metric. The Statewide CASE Team recommends that the Energy Commission leverage the work of the AMCA 208 committee.

7. Marking and Labeling Requirements

7.1 Current Marking and Labeling Requirements

Currently, there are no marking and labeling requirements for fans and blowers. Fan manufacturers voluntarily submit fan data to become "AMCA Certified," which is a process whereby independent AMCA tests affirm the manufacturer provided product performance data over the fan operating range. This process is governed by the AMCA 210 Standard.

7.2 Proposed Marking and Labeling Requirements

Marking and labeling requirements may be an important component of fan efficiency standards. The stakeholder Working Group term sheet outlined various information for what should be included on the label when the design point is known and when it is unknown.[10] It should also be noted that AMCA is planning a revision to AMCA 211, which may address marking and labeling requirements as well. Past editions of AMCA 211 have addressed FEG labeling requirements.

The DOE rulemaking negotiations and agreements have led to an innovative regulatory approach, whereby the published operating points of regulated fans would be limited based on the FEI rating at each point. Subsequently, fan selectors would be forced to choose a fan where the desired operating point meets the standard level. This would steer engineers and others who select fans toward the most efficient fans to meet the pressure and flow requirements of the application. Although it is unlikely that many fans would be banned from the marketplace outright due to an eventual standard, less efficient fans would be shown to have very small allowable operating regions, and would likely be retired from service voluntarily due to low sales. This would steer the market toward more efficient fans.

8. Energy Usage

8.1 Efficiency Measures

There are multiple efficiency metrics for fans in existence. The metrics vary slightly, but ultimately aim to quantify how effectively the fan equipment transfers energy into the airstream. ASHRAE 90.1 currently specifies a minimum FEG, though this metric has fallen out of favor with the fan

[10] https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0179 (Recommendation #30 and #31)

industry and efficiency advocates. The DOE ASRAC Term Sheet used FEP as the recommended metric and stated that FEI should be allowed for representation.

In its invitation to participate, the Energy Commission stated that it is deciding between the FER (Fan Energy Rating) and FEI metrics. The FER metric has not been discussed as an option by AMCA or DOE in several years, and eventually evolved into the FEP/FEI framework. Currently, the discussion centers around whether to use FEP or FEI as the regulated metric. FEP is a metric that has units of kilowatts (kW). FEP metric is defined in Equation 1.

Equation 1

$$FEP_{STD,i} = 0.746 \times \left(\frac{Q_i \times P_i}{6343 \times \eta_{STD,i}} \times \frac{1}{\eta_{T,i}} + L_{M,i} \right)$$

In Equation 1, Q_i refers to the airflow (cfm) at operating point i. P_i refers to total pressure for ducted fans, and static pressure for un-ducted fans (in w.c.) at operating point i. $\eta_{STD,i}$ refers to the standard level fan total efficiency for ducted fans and the standard level fan static efficiency for unducted fans at operating point i. $\eta_{T,i}$ refers to the default transmission efficiency at operating point i. $L_{M,i}$ refers to the default electric motor losses in hp at operating point i.

FEI is a ratio of two FEP values, shown in Equation 2.

Equation 2

$$FEI = \frac{FEP_{STD}}{FEP}$$

Recently, the industry and other stakeholders are coalescing around the Fan Energy Index (FEI) as the preferred regulated metric. While both the FEP and FEI metrics could conceivably be adopted as the regulated metric by the Energy Commission, there are compelling reasons to choose FEI. DOE had been reluctant to use FEI, because it argued that in the future, every time the standard were to be updated, the past values of FEI would become outdated and all prior literature would be obsolete. This barrier can be overcome, however, by using a fixed "reference FEP" that would remain fixed for all time going forward. Standards could then be built off that reference and would increase in stringency over time. Effectively, Equation 2 would be adjusted so that the numerator is the "reference FEP" that would never change, and then successive iterations of standards would increase the minimum FEI).

Industry actors prefer FEI to FEP, because an FEI rating is intuitive and would more easily facilitate comparisons among fan models. Additionally, FEI plots on fan curves are significantly more useful and intuitive than FEP plots. An engineer can make decisions based off FEI values, while they would need additional information beyond the equipment's FEP rating to know how the power consumption relates to the power consumption of an efficient fan.

Ultimately, the choice between FEP and FEI will not substantially impact the final energy savings that can be achieved by this rulemaking. Both metrics use the concept of measuring "wire-to-air" efficiency, which accounts for motor losses, transmission losses, and aerodynamic losses between the fan blades and the airstream. However, the growing consensus between manufacturers and efficiency advocates make FEI the more compelling choice.

8.2 Per Unit Energy Savings Methodology

Energy savings estimates are currently available in DOE's supporting data, specifically the national impact analysis spreadsheet.

9. References

U.S. DOE. "Energy Conservation Standards for Commercial and Industrial Fans and Blowers." DOE Docket. https://www.regulations.gov/docket?D=EERE-2013-BT-STD-0006

Ivanovich, Michael, et al. "Introducing the Fan Energy Index." Air Movement and Control Association. October 2016. https://www.amca.org/resources/documents/Introducing%20the%20Fan%20Energy%20Index%20Metric.pdf

[U.S. DOE] "Energy Conservation Standards for Commercial and Industrial Fans and Blowers: Availability of Provisional Analysis Tools." Federal Register 81. November 2016. https://www.federalregister.gov/documents/2016/11/01/2016-26341/energy-conservation-standards-for-commercial-and-industrial-fans-and-blowers-availability-of

[U.S. DOE] "Energy Conservation Standards for Commercial and Industrial Fans and Blowers: Notice of Proposed Determination of Coverage." Federal Register 76. June 2011. https://www.gpo.gov/fdsys/granule/FR-2011-06-28/2011-16134

ASHRAE. "Energy Standard for Buildings Except Low-Rise Residential Buildings." Standard 90.1-2016.

Working Group Term Sheet: Appliance Standards and Rulemaking Federal Advisory Committee Commercial and Industrial Fans and Blowers Working Group Term Sheet, September 3, 2015 (edited September 24, 2015). https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0179

[U.S. DOE] "DOE Energy Conservation Standards for Commercial and Industrial Fans and Blowers." NODA National Impact Analysis (NIA) Spreadsheet. 2016. https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0192

Cermak, John and Ivanovich, Michael. "Fan Efficiency Requirements for Standard 90.1-2013.". ASHRAE Journal. April 2013. http://www.amca.org/UserFiles/file/024-031_cermak_WEB.pdf

DOE Energy Conservation Standards for Commercial and Industrial Fans and Blowers, 2016 NODA Life-Cycle Cost (LCC) and Payback Period (PBP) Spreadsheet. https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0190

"Greenheck Computer Aided Product Selection Program." Greenheck. http://www.greenheck.com/content/view/software_caps