

DOCKETED

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AHRI presentation

AHRI presentation in response to commercial and industrial fans and blowers proposed regulation and staff report.

Additional submitted attachment is included below.

AHRI Presentation

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

Wednesday, July 11, 2018

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

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

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, unhooded 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

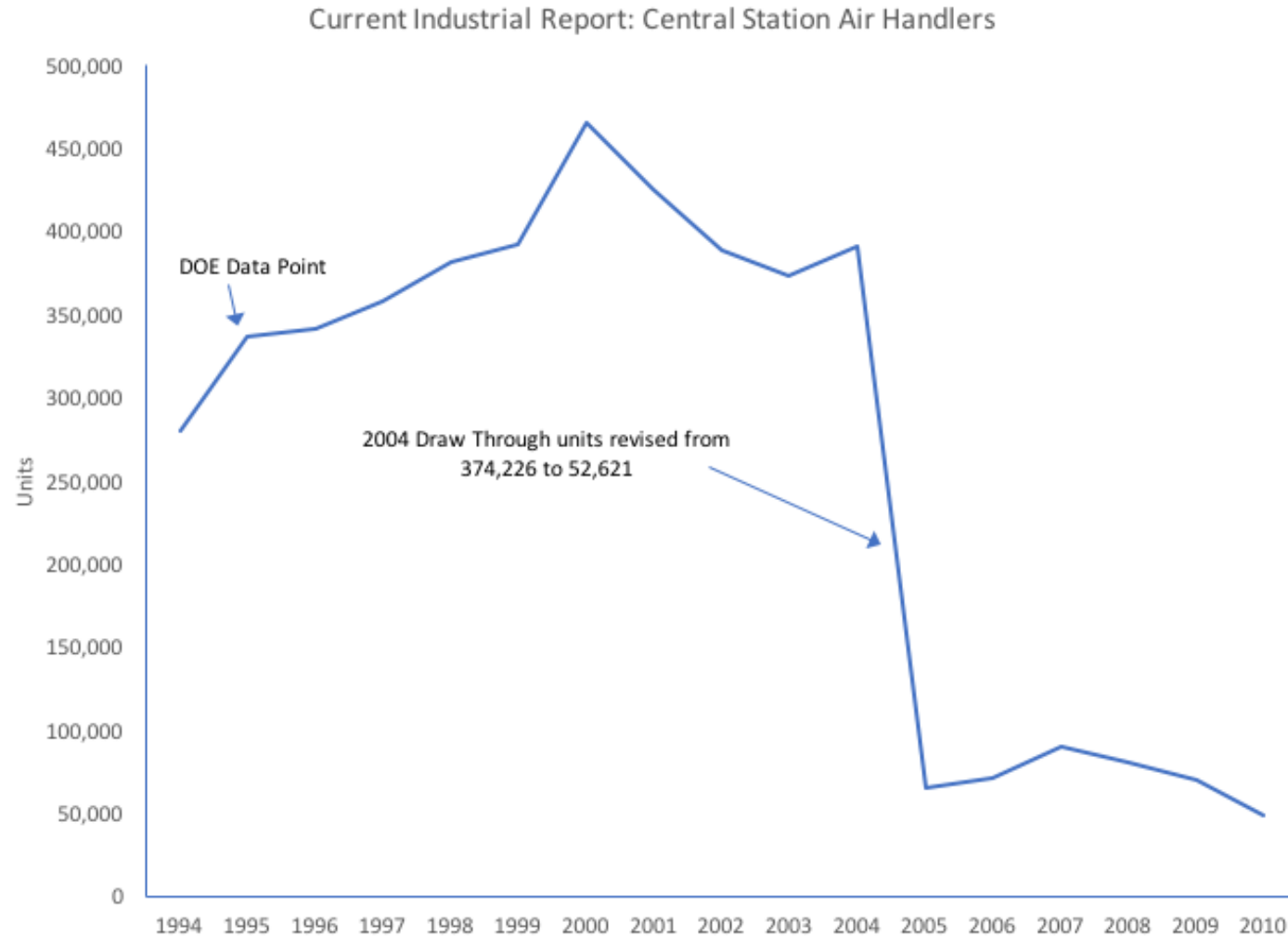
Centrifugal Fans

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

Centrifugal Fans

DOE Relied on Incorrect Data from Current Industrial Report



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

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%)

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

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.

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.

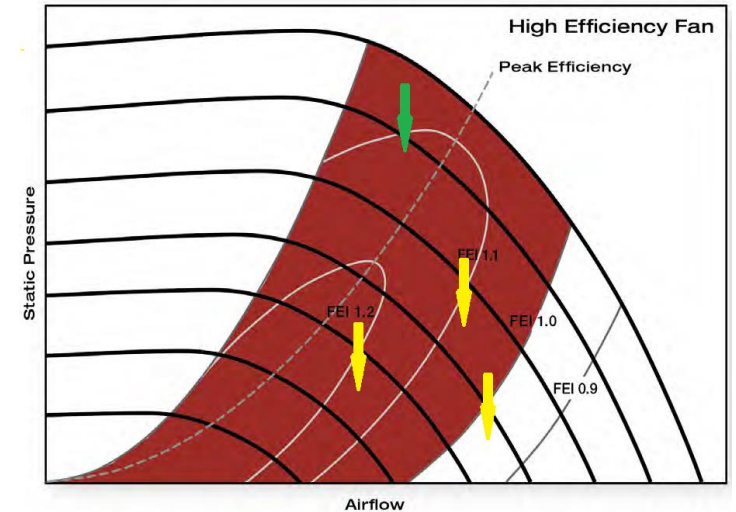
The FEI Paradox

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.



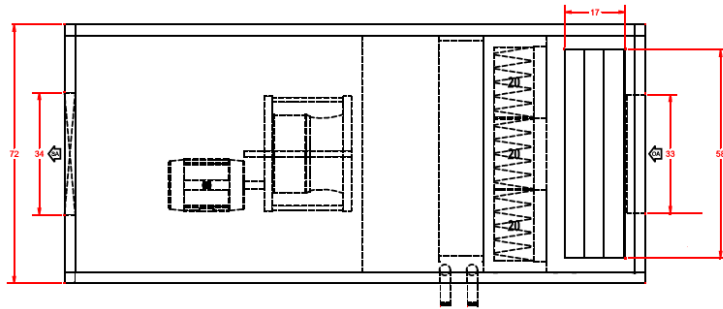
Each arrow represents a change in system design where the airflow and fan remain the same, but flow resistance is reduced.

- 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.

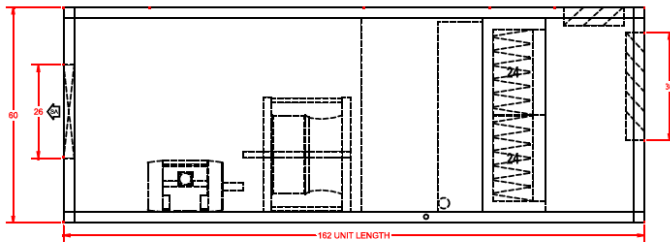
The FEI Paradox

Lower AHU power consumption yields lower FEI

Unit A

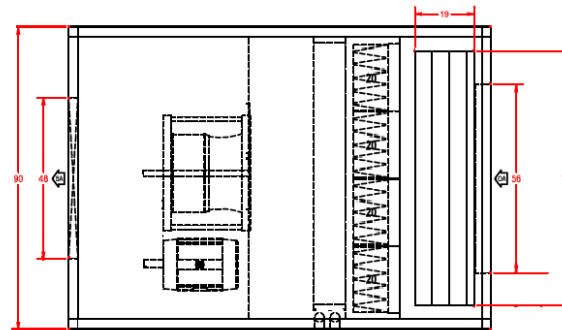


PLAN VIEW

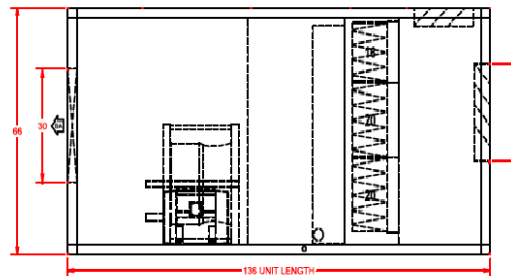


Fan Static Pressure Rise: 4.35 in. H₂O
Fan Brake Horsepower: 12.88 HP
FEI: 1.17

Unit B



PLAN VIEW



Fan Static Pressure Rise: 2.46 in. H₂O
Fan Brake Horsepower: 8.44 HP
FEI: 1.09

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

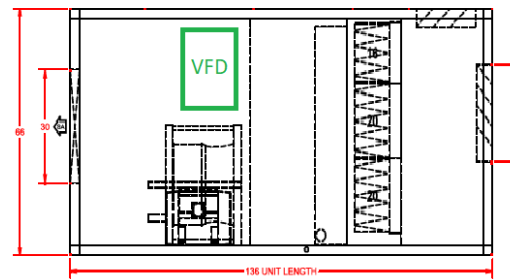
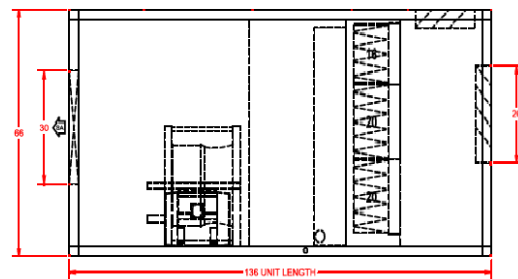
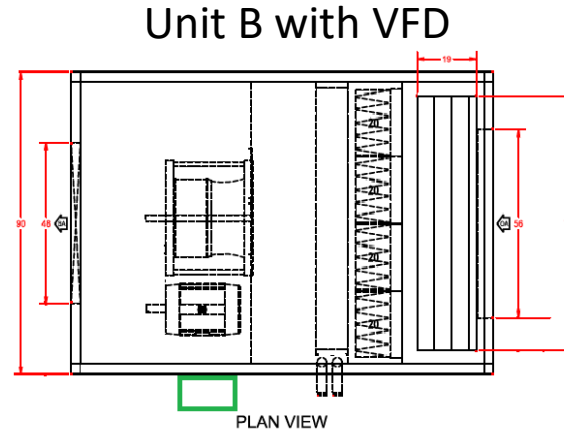
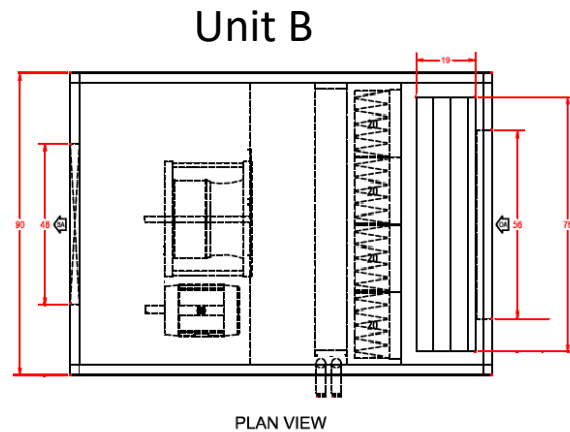
The difference: Unit B has:

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

FEP calculated per AMCA 208 section 5.3.2

The FEI Paradox

A Variable Speed Drive is more efficient?



Fan Static Pressure Rise: 2.46 in. H₂O
Fan Brake Horsepower: 8.44 HP
FEI: 1.09

Fan Static Pressure Rise: 2.46 in. H₂O
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

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.

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 FEP (calculated per AMCA 207 or tested) be included on the label.

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

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

Questions?

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