BUILDING TECHNOLOGIES PROGRAM

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy






Notice of Proposed Rulemaking (NOPR) Public Meeting on Test Procedures for Residential Furnace Fans

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June 15, 2012

Welcome and Introductions

- Introductions
- Role of the Facilitator
- Ground Rules (norms)
  - Listen as an ally.
  - Use short, succinct statements/keep to the point.
  - Hold sidebar conversations outside the room.
  - Focus on issues, not personalities.
  - One person speaks at a time (raise hand to be recognized; state your name for the record).
  - Set cell phones to silent/vibrate.
- Housekeeping Items

Listening Via the Webcast

- The Department is broadcasting this meeting live over the Internet.
- DOE is providing the webcast to accommodate interested parties that are unable to attend the public meeting in person.
- The web broadcast allows interested parties to listen in and view the presentation slides.
- All interested parties are encouraged to submit written comments after the public meeting.
- All microphones in the room should be muted unless speaking to control feedback on the phone line.

Purpose of the Public Meeting

- Purpose
  - To present DOE's proposed test procedure for residential furnace fans;
  - To seek comment from participants on the proposed test procedure;
  - To discuss specific issues or questions related to the proposal; and
  - To describe next steps in the test procedure rulemaking.

- Comments from Participants
  - Participants are invited to provide summary comments or statements and raise additional issues for discussion.
  - The NOPR was published in the *Federal Register* on May 15, 2012 (77 FR 28674), and the NOPR comment period closes July 30, 2012.

Request For Comment

Issue Box: The U.S. Department of Energy (DOE) welcomes comments, data, and information concerning its NOPR for residential furnace fans. Issues that correspond to those raised in the DOE's published material will be numbered in accordance with that material. Whether invited by an issue box or not, comments are welcome on any part of DOE's analysis.

(Issue #)

Issue box numbering corresponds to the list of issues published at the end of the NOPR, available at: http://www1.eere.energy.gov/buildings/appliance_standards/residential/furnace_fans.html

DOE Seeks Comments on its Proposal

- In all correspondence, please include all of the following:
  - Test Procedure for Residential Furnace Fans
  - Docket Number: EERE-2010-BT-TP-0010
  - Regulatory Identification Number (RIN):1904-AC21

- Contact Information

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Comment period closes: July 30, 2012

Public Meeting Agenda

1. Introduction and Overview
2. Scope of Applicability
3. Reference Standards
4. Fan Efficiency Rating (FER)
5. Rating Examples
6. Certification, Compliance & Enforcement
7. Closing Remarks

- EPCA directs DOE to establish test procedures in conjunction with new or amended energy conservation standards, including furnace fans. (42 U.S.C. 6295(o)(3)(A))
  - Under 42 U.S.C. 6295(f)(4)(D), EPCA directs DOE to consider and prescribe standards for electricity used for purposes of circulating air through duct work (hereinafter referred to as "furnace fans") no later than December 31, 2013.

- 42 U.S.C. 6293(b)(3) states that test procedures shall be reasonably designed to produce test results which reflect the energy efficiency or energy use of a product during a representative average use cycle and shall not be unduly burdensome to conduct.

- EPCA requires that DOE integrate into the energy conservation standard the energy use associated with standby mode and off mode, unless the current standard already accounts for standby mode and off mode energy consumption or integration is not technically feasible. In the latter case, EPCA requires that DOE prescribe a separate efficiency standard to address standby mode and off mode energy use, unless that is not feasible. (42 U.S.C. 6295(gg)(3)) Accordingly, DOE's furnace fan test procedure must account for standby mode and off mode energy use. (42 U.S.C. 6295(gg)(2))

- DOE currently has no energy conservation standard or test procedure for residential furnace fans.

- On June 3, 2010, DOE published a Notice of Public Meeting and Availability of the Framework Document to initiate the energy conservation standard rulemaking for furnace fans. 75 FR 31323.

- DOE published the furnace fans test procedure NOPR on May 15, 2012.
- DOE is holding the NOPR public meeting today, June 15, 2012.
- DOE will accept comments on NOPR from interested parties.
  - Oral comments from today's meeting will be recorded and transcribed.
  - Interested parties can submit written comments until July 30, 2012.
- DOE reviews and considers all comments.
- DOE expects to issue a test procedure Final Rule by December 31, 2012.

- Comments from Participants
  - Participants are invited to provide summary comments or statements.
  - Participants are invited to raise additional issues for discussion today.
  - Participants are invited to submit comments during the NOPR comment period, which is open through July 30, 2012.

- Opening Remarks
  - At this time, DOE welcomes opening remarks from interested parties on the test procedure NOPR for residential furnace fans.

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Scope of Applicability

- Scope of applicability includes single-phase, electrically-powered devices that circulate air through duct work in heating, ventilation, and air-conditioning (HVAC) products with:
  - Heating capacities less than 225,000 Btu per hour; and
  - Cooling capacities less than 65,000 Btu per hour.

- These criteria are consistent with current DOE definitions for residential "furnace" and "central air conditioner (CAC)." (10 CFR 430.2)

- DOE finds that HVAC products that meet these criteria typically have airflow capacities less than 3,000 cfm.

- DOE proposes to exclude any non-ducted products, such as:
  - Whole-house ventilation systems without duct work;
  - CAC condensing unit fans;
  - Room fans; and
  - Furnace draft inducer fans.

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Reference Standards

DOE selected reference standards that are widely used by industry participants for the purpose of measuring fan performance and standby mode and off mode electrical energy consumption.

- Active Mode
  - ANSI/AMCA 210-07 | ANSI/ASHRAE 51-07: *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.*
- Standby Mode and Off Mode (hydronic air handlers only)
  - DOE standby mode and off mode test procedure for residential furnaces. (10 CFR part 430, subpart B, appendix N, section 8.6)
  - International Electrotechnical Commission (IEC) Standard 62301 (Second Edition), *Household electrical appliances – Measurement of standby power.*

Reference Standards

ANSI/AMCA 210-07

DOE incorporated by reference the sections required to calculate the proposed metric, the "fan efficiency rating" (FER).

- Sections incorporated by reference:
  - Definitions, units of measure, and symbols (section 3);
  - Instruments and methods of measurement (sections 4.1 to 4.3 and 4.6);
  - Test setup and equipment provisions (section 5) and observation and conduct of test guidelines (section 6);
  - Calculations (sections 7.1 to 7.7 and section 7.9); and
  - Report and results of test requirements (section 8).

- Sections not incorporated by reference:
  - Mechanical measurement of fan input power and motor calibration (section 4.4) and rotational speed (section 4.5);
  - Test data to be recorded for rotational speed (N), beam load (F), or torque (T); and
  - Calculations for fan power input or fan efficiency (sections 7.7 and 7.8).

DOE proposes the following specifications in addition to the methods incorporated by reference from ANSI/AMCA 210-07:

- The range and increments of external static pressures (ESP) at which "determinations" (i.e., measurement of airflow, electrical consumption, and ESP) are to be made;
- Use of an electrical meter to measure electrical energy consumption with a certified accuracy of ±1 percent of observed readings at each determination to replace the mechanical methods specified in section 4.4 of ANSI/AMCA 210-07; and
- Electrical supply be maintained within 1 percent of the highest nameplate voltage.

DOE expects that the term "external static pressure" used by manufacturers is synonymous with the term "fan static pressure" as defined by ANSI/AMCA 210-07.

- Fan static pressure: The difference between the fan total pressure and the fan velocity pressure. Therefore, it is the difference between static pressure at the fan outlet and total pressure at the fan inlet. *(ANSI/AMCA 210 definition)*

- External static pressure**:** The difference between the fan total pressure at the air outlet and the total pressure at the air inlet less velocity pressure at the air outlet of an HVAC product containing a furnace fan when operating and installed in accordance with the manufacturer's instructions. External static pressure does not include the pressure drop across appurtenances internal to the HVAC product. *(NOPR definition)*

DOE requests comments on the proposed definition of "external static pressure" and whether DOE is correct in assuming that external static pressure ratings reported in product literature are equivalent to ANSI/AMCA 210-07 fan static pressure measurements.

(Issue 8)

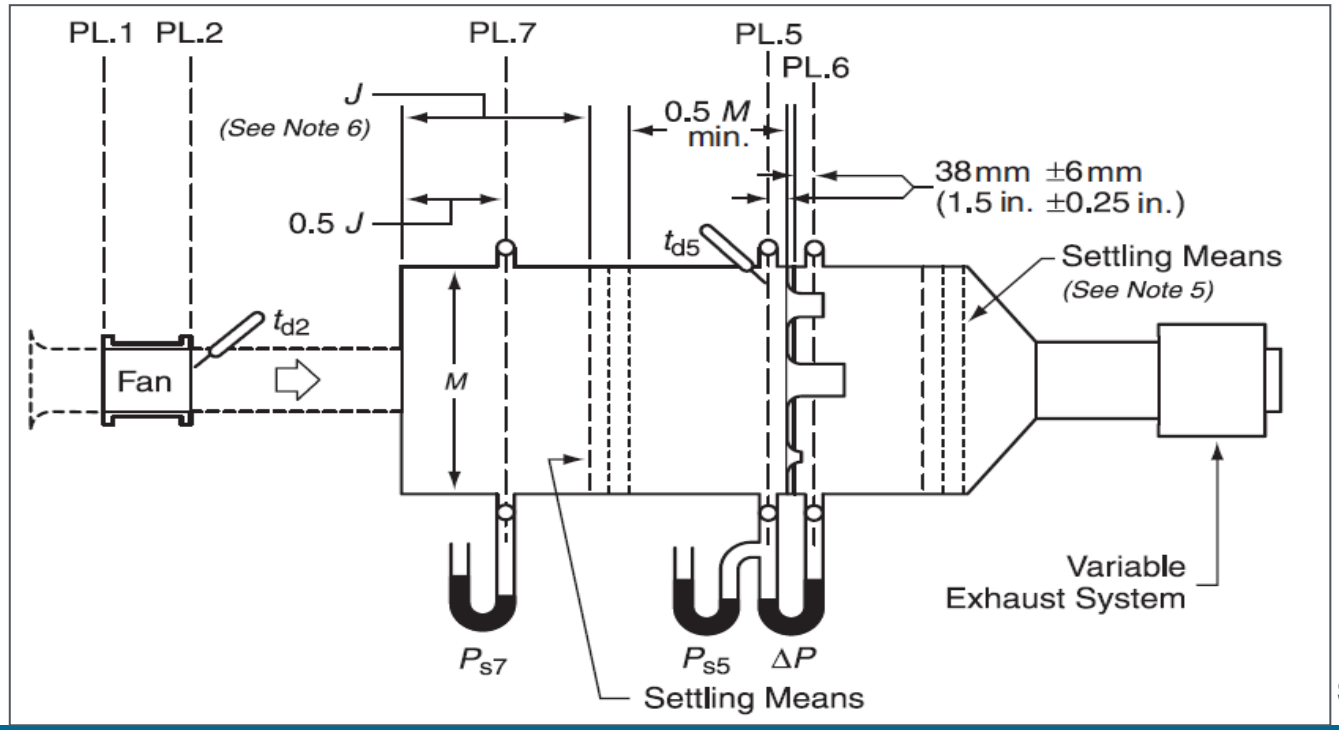
External Static Pressure

Theoretical calculation of external static pressure:

- $P_{total} = P_{static} + P_{velocity} \therefore P_{static} = P_{total} - P_{velocity}$
- $\Delta P_{static} = P_{s,outlet} - P_{s,inlet} = \left(P_{total} - P_{velocity}\right)_{outlet} - \left(P_{total} - P_{velocity}\right)_{inlet}$

Fan static pressure as defined in AMCA 210 and adopted for ESP in NOPR:

- $\Delta P_{static} = P_{s,outlet} - P_{s,inlet} = \left(P_{total} - P_{velocity}\right)_{outlet} - P_{total,inlet}$
- $\Delta P = P_7 - P_1$



Source: ANSI/AMCA 210-07

- DOE recognizes that ANSI/AMCA 210-07 includes 16 setup variations.
- DOE did not propose a particular variation.
- DOE expects that the blow-through setups, such as test setup 12, may be more appropriate than pull-through setups, such as setup 13, because they are more representative of typical installations of the HVAC products that incorporate furnace fans.

DOE requests comments on which of the ANSI/AMCA 210-07 setups are best-suited for the purposes of this test procedure. DOE also requests comments on whether any of these test setups are inappropriate and should be disallowed for the purposes of this test procedure.

(Issue 7)

- DOE is aware that barometric pressure changes may have an impact on test measurement results.

- DOE notes that the ANSI/AMCA 210-07 standard does not appear to include correction for this effect.

DOE requests comment on whether any limitations on the barometric pressure range or adjustments to address the impact of barometric pressure should be included in the test procedure.

(Issue 9)

Reference Standards

DOE Furnace Standby Test Procedure (IEC 62301)

DOE is addressing standby mode and off mode energy use in test procedures for residential furnaces and CAC, but not hydronic air handlers.

HVAC Products	Status	Latest DOE Rulemaking Activity
• **Gas Furnaces** • **Oil-fired Furnaces** • **Electric Furnaces**	Being addressed in separate rulemaking	• September 13, 2011 Furnaces NOPR (76 FR 56339).
• **Modular Blowers** • **Weatherized Gas Furnace**	Being addressed in separate rulemaking	• October 24, 2011 CAC SNOPR (76 FR 65616).
• **Hydronic Air Handlers**	Being addressed in current rulemaking	• N/A

- DOE finds that the electrical systems (i.e., components and controls) of hydronic air handlers are similar to the electrical systems of furnaces.

- DOE proposes to incorporate the methods specified in the DOE test procedure for residential furnaces and boilers to measure the standby mode and off mode energy consumption for furnace fans used in hydronic air handlers. (10 CFR part 430, subpart B, appendix N, section 8.0)

DOE seeks comment on whether the assumed similarities between the electrical systems of furnaces and hydronic air handlers are appropriate. DOE seeks comment on whether the methods for measuring standby mode and off mode energy consumption specified in the DOE test procedure for residential furnaces and boilers are appropriate for hydronic air handlers.

(Issue 5)

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Fan Efficiency Rating (FER)

- FER is the estimated annual electrical energy consumption normalized by:
  1. annual rated operating hours, and
  2. the airflow in the maximum airflow-control setting in standard cubic feet per minute.

- The annual rated operating hours varies by product type depending on whether standby mode and off mode operating hours are considered.

- The estimated annual electrical energy consumption is a weighted average of the fan input power measured separately for multiple airflow-control settings at different external static pressures (ESPs).
  - The airflow-control settings proposed to be rated correspond to operation in cooling mode, heating mode, and constant-circulation mode.
  - Power and airflow measurements are taken at ESPs that are determined by a reference system that represents national average duct work characteristics.
  - The input power is weighted by estimated national average operating hours for each rated airflow-control setting.

Fan Efficiency Rating

Rated Airflow-Control Settings

- DOE is aware that furnace fans typically have multiple airflow-control settings.

- DOE expects that each airflow-control setting is typically designated to perform a specific function (i.e., constant circulation, heating, or cooling).

- DOE expects that airflow-control setting designations are as follows:
  - Lowest settings are designated for constant circulation.
  - Median settings are designated for heating.
  - Highest settings designated for cooling.

Fan Efficiency Rating

Rated Airflow-Control Settings

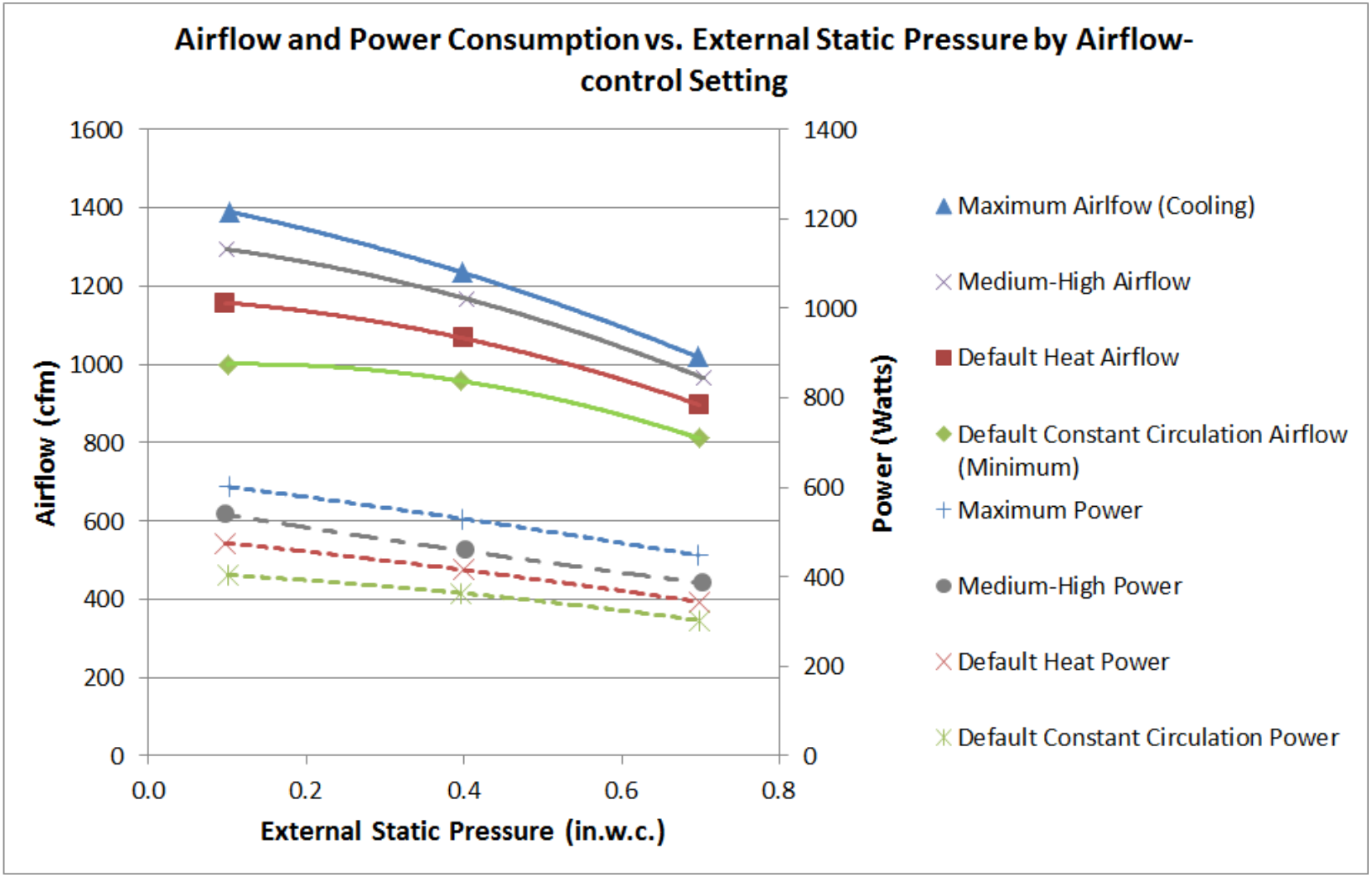
- DOE found that rating three of the available airflow-control settings captures efficiency improvements while minimizing burden on manufacturers.

Product Type	Proposed Lowest Rated Setting	Proposed Median Rated Setting	Proposed Highest Rated Setting
Single-Stage Heating	Default constant-circulation	Default heat	Maximum (Cooling)
Multi-Stage or Modulating Heat	Default constant-circulation	Default lowest heat	Maximum (Cooling)
Heating-only	Default constant-circulation	None	Maximum (Heating)

- Default airflow-control settings are the airflow-control settings that can be achieved in the factory-set control system configuration (i.e., without manual adjustment other than interaction with a user-operable control such as a thermostat).

Fan Efficiency Rating

Rated Airflow-Control Settings



- Data from a non-weatherized, non-condensing gas furnace fan with a 4-speed PSC motor.

Request For Comment

Rated Airflow-Control Settings

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DOE seeks comment on the appropriateness of the proposed assumptions regarding which airflow-control settings are designated for which functions and whether these assumed designations are appropriate for deriving FER. DOE also seeks comment on airflow-control setting designations for multi-stage products.

(Issue 1)

Fan Efficiency Rating

Reference System

- A reference system is used to represent national average ductwork characteristics, which allows for comparison of fan performance at common operating conditions across products.

- A reference system curve is in the form of an equation that models the relationship between *ESP* and airflow, *Q*, as determined by the physical characteristics, *K*, of the system.

$$ESP = K \times Q^2$$

- For this test procedure, DOE proposes to define a reference system by a specified ESP value and the airflow delivered by the fan at that ESP value in the maximum airflow-control setting.

$$K_{ref} = \frac{ESP_{ref}}{{Q_{max}}^2}$$

1. DOE compiled over 1,300 field measurements of ESP in the maximum airflow-control setting.

2. DOE identified four installation types:
   - Heating-only units;
   - Units with an internal evaporator coil;
   - Units designed to be paired with an evaporator coil; and
   - Manufactured home units.

3. DOE adjusted ESP values to derive one value that included reported evaporator coil pressure drop and one that did not. All values included reported filter pressure drop.
   - The average pressure drop reported for an evaporator coil was 0.20 in.w.c.
   - The average pressure drop reported for an air filter was 0.21 in.w.c.

Household Type	With Coil ESP (in.w.c.)	Without Coil ESP (in.w.c.)
Single-family Home	0.73	0.52
Manufactured Home	0.37	0.17

4. DOE weighted results by the fraction of furnace installations paired with an evaporator coil in the field. Based on EIA's RECS 2005 data:
   - 72.9% of non-weatherized gas and oil furnaces in single-family households are paired with evaporator coils; and
   - 50.2% of non-weatherized gas and oil furnaces in manufactured home households are paired with evaporator coils.

Fan Efficiency Rating

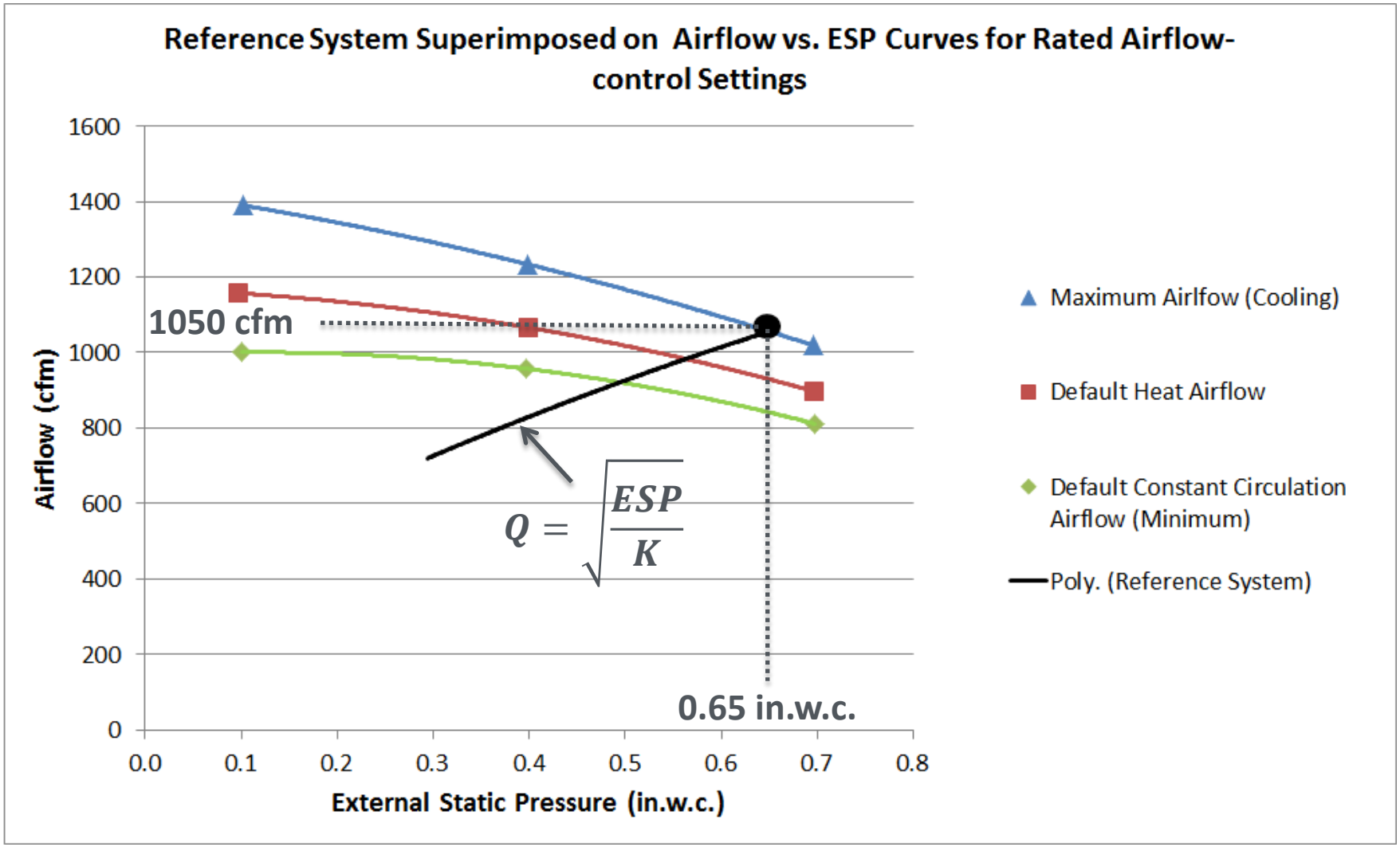
Reference System

Installation Type	Weighted Average ESP in Maximum Airflow-Control Setting* (in.w.c.)
Heating-only units	0.50
Units with an internal evaporator coil	0.50
Units designed to be paired with an evaporator coil	0.65
Manufactured home units	0.30

*rounded to nearest 0.05 in.w.c.

Fan Efficiency Rating

Reference System



- Data from a non-weatherized, non-condensing gas furnace fan with a 4-speed PSC motor.

Request For Comment

Reference System ESP Values

DOE seeks comment and data regarding the proposed reference system ESP values and the assumptions DOE used to estimate them. DOE also seeks comment on whether the specified reference system ESP should vary with the HVAC product capacity.

(Issue 3)

Request For Comment

Reference System ESP Values

- DOE is aware that field ESPs can be higher than recommended by manufacturers.

- DOE is also aware that the Canadian Standard Association (CSA) specified rating fan performance using multiple reference systems in CSA C823-11 *Performance of air handlers in residential space conditioning systems*:
  - One reference system at 0.3 in.w.c. in the heating setting to represent a manufacturer-recommended installation, and
  - One reference system at 0.6 in.w.c. in the heating setting to be representative of a "common" field installation. *(CSA C823-11, Section 9.1)*

DOE requests comment on multiple-reference system rating approaches and whether they would give a better indication of the overall performance, as compared to the proposed single reference system approach.

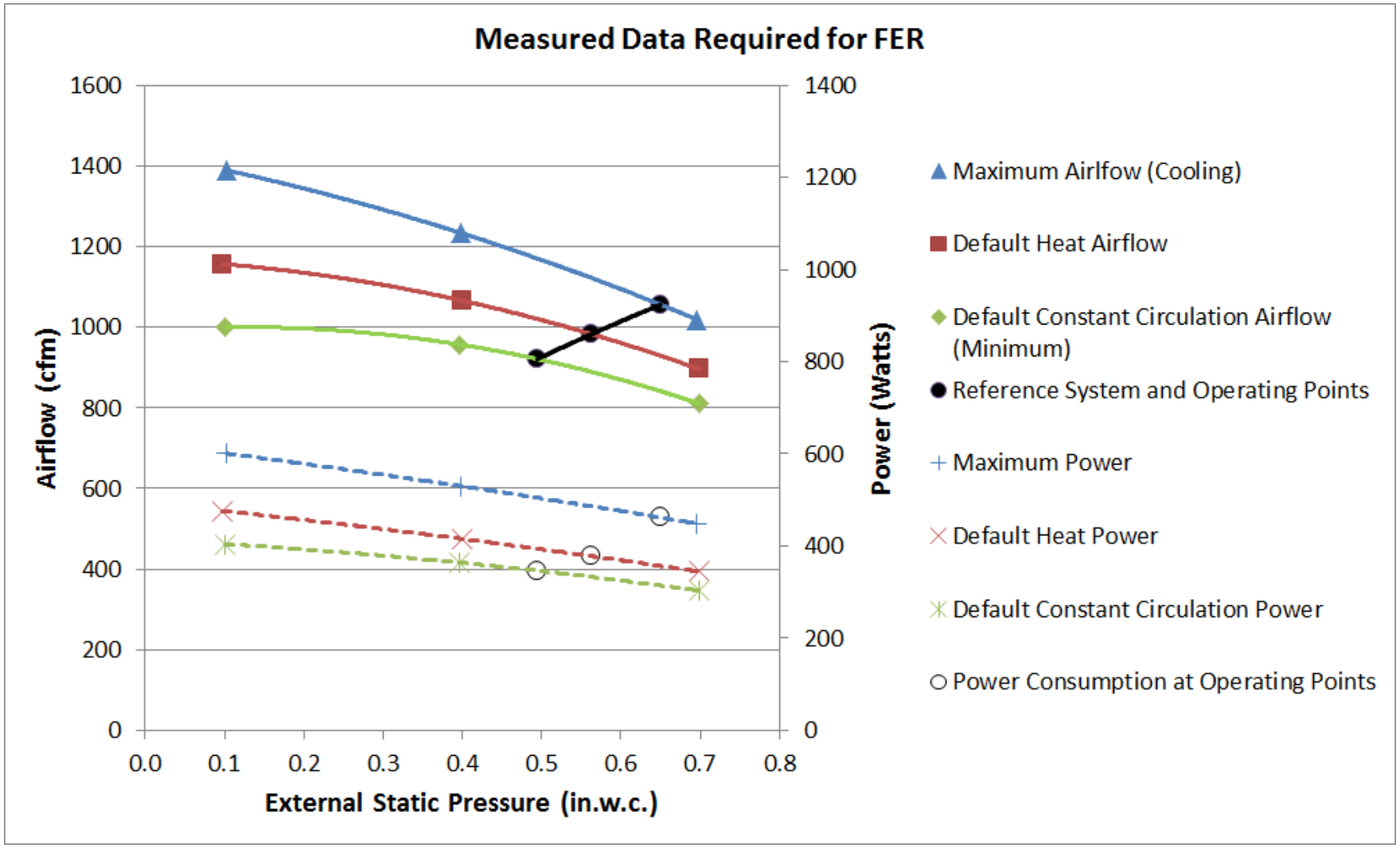
(Issue 4)

- For each rated airflow-control setting DOE proposes to specify determinations at:
  - 0.1 in.w.c.;
  - An ESP equal to the applicable reference system ESP divided by 2; and
  - An ESP between the applicable reference system ESP and 0.1 in.w.c. above that reference system ESP.

- Three determinations in each of three rated airflow-control settings results in a total of nine determinations required to generate the FER for a given residential furnace fan.

Fan Efficiency Rating

Measured Data



- Data from a non-weatherized, non-condensing gas furnace fan with a 4-speed PSC motor.

Fan Efficiency Rating

Operating Hours Methodology

- DOE used the following equation to estimate national average heating and cooling fan operating hours:

$$Hours = Fan\ on - time\ ratio \times \frac{Weather\ Factor \times Average\ Annual\ Energy\ Use}{Input\ Capacity}$$

- DOE used results from constant circulation use studies conducted in Wisconsin and Minnesota to estimate national average constant circulation fan operating hours. DOE adjusted the survey results because homes in Wisconsin and Minnesota use constant circulation more than the typical U.S. home for the following reasons:
  - WI and MN homes have low air infiltration due to building codes.
  - WI and MN residents have a high awareness of indoor air quality issues.
  - WI and MN homes are located in a northern climate region.

- DOE proposes a value of zero for hydronic air handler off mode operating hours because DOE expects that hydronic air handlers are not typically equipped with a seasonal off switch or that consumers will not turn off power to the hydronic air handler.

- DOE estimates that the average annual standby mode fan operating hours is equal to the remainder of annual hours not designated for cooling, heating, constant circulation, or off mode.

Fan Efficiency Rating

Operating Hours Estimates

Operating Mode	Variable	Single-Stage Heating (hours)	Multi-Stage Heating (hours)
Heating Mode	HH	830	830/HCR
Circulation Mode	CCH	400	400
Cooling Mode	CH	640	640
Off Mode (if applicable)	OH	0	0
Standby Mode (if applicable)	SBH	8760-HH-CCH-CH-OH	8760-HH-CCH-CH-OH

- The heat capacity ratio (HCR) is the ratio of output heat capacity in the low heat setting to the output heat capacity ratio in the high heat setting.

Fan Efficiency Rating

Operating Hours Methodology

- DOE proposes to account for the differences in operation between single-stage heating and multi-stage or modulating heating units in its estimated annual heating fan operating hours.

- DOE finds that the low heat setting typically accounts for 90 percent or more of heating operation time, requiring more heating operating hours for a multi-stage furnace fan than a single-stage furnace fan to provide the same total delivered heating in a given installation.

- DOE proposes to use the following equation to determine average annual heating operating hours for multi-stage and modulating furnace fans:

$$HH_m = \frac{830}{HCR}$$

Request For Comment

Operating Hour Estimates

DOE requests comment on whether the proposed operating hour values are reasonable estimations of national average operating hours for each furnace fan function. DOE also requests comment on the methodology and assumptions used to estimate these values. DOE also requests comment on whether hydronic air handlers are designed to provide multi-stage or modulated heat. DOE requests comments on whether the proposed operating hour values and proposed rating airflow-control settings are appropriate for rating multi-stage and modulating hydronic air handlers.

(Issue 2)

DOE seeks comment on whether hydronic air handlers have a seasonal off switch or consumers would turn off power to the hydronic air handler. If so, DOE also requests comment on the expected electrical energy consumption in off mode, the number of hours that should be allocated to standby mode, and the number of hours that should be allocated to off mode, as well as data to support these allocations.

(Issue 5)

Fan Efficiency Rating
Variations

- General form:

$$FER = \frac{\sum_{x=rated\ modes}(Operating\ Hours_x \times Power\ Consumption_x)}{(\sum_{x=rated\ modes} Operating\ Hours_x) \times (Maximum\ Airflow)} \times 1000$$

- Non-hydronic Furnace Fans:

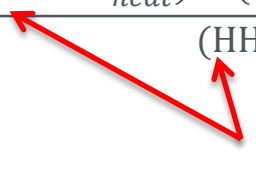
$$FER = \frac{(CH \times E_{max}) + (HH \times E_{heat}) + (CCH \times E_{circ})}{(\mathrm{CH} + \mathrm{HH} + \mathrm{CCH}) \times Q_{max}} \times 1000$$

- Heating and Cooling Hydronic Furnace Fans:

$$IFER_{hydronic} = \frac{(CH \times E_{max}) + (HH \times E_{heat}) + (CCH \times E_{circ}) + (SBH \times E_{SB}) + (OH \times E_{OFF})}{(\mathrm{CH} + \mathrm{HH} + \mathrm{CCH} + \mathrm{SBH} + \mathrm{OH}) \times Q_{max}} \times 1000$$

- Heating-only Hydronic Furnace Fans:

$$IFER_{heating-only} = \frac{(HH \times E_{heat}) + (CCH \times E_{circ}) + (SBH \times E_{SB}) + (OH \times E_{OFF})}{(\mathrm{HH} + \mathrm{CCH} + \mathrm{SBH} + \mathrm{OH}) \times Q_{max}} \times 1000$$



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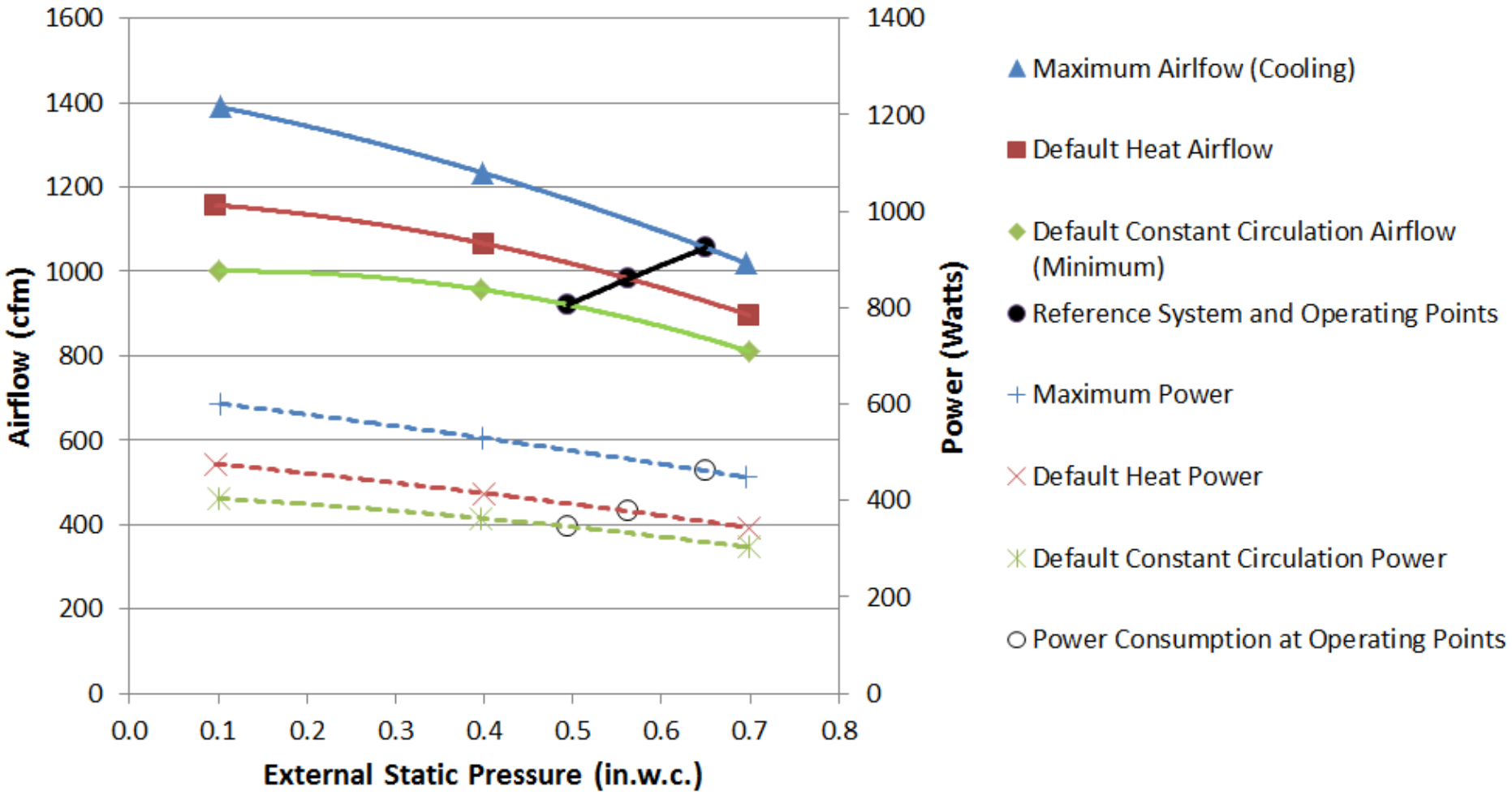
FER Example


FER Test Data for a Non-weatherized gas, non-condensing furnace fan with a 4-speed PSC Motor
Airflow (cfm)
Power (Watts)
External Static Pressure (in.w.c.)
1600
1400
1200
1000
800
600
400
200
0
1400
1200
1000
800
600
400
200
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Maximum Airlfow (Cooling)
Default Heat Airflow
Default Constant Circulation Airflow (Minimum)
Reference System and Operating Points
Maximum Power
Default Heat Power
Default Constant Circulation Power
Power Consumption at Operating Points

FER Example

Non-weatherized, non-condensing gas furnace fan with a 4-speed PSC motor.

Function	Power (W)	Annual Operating Hours	Annual Energy Consumption (Wh)
Cooling	450	640	288,000
Heating	375	830	311,250
Constant-Circulation	350	400	140,000
Standby	NA	NA	NA
Total		1,870	739,250

$$FER = \frac{Annual\ Energy\ Consumption}{Airflow\ at\ Max\ Operating\ Point \times Total\ Annual\ Operating\ Hours} \times 1000$$

$$FER = \frac{739{,}250\ Wh}{1{,}050\ cfm \times 1{,}870\ hours} \times 1000 = \mathbf{376\ Watts\ per\ 1000\ cfm}$$

IFER Example

Heating and cooling hydronic air handler furnace fan with an ECM motor.

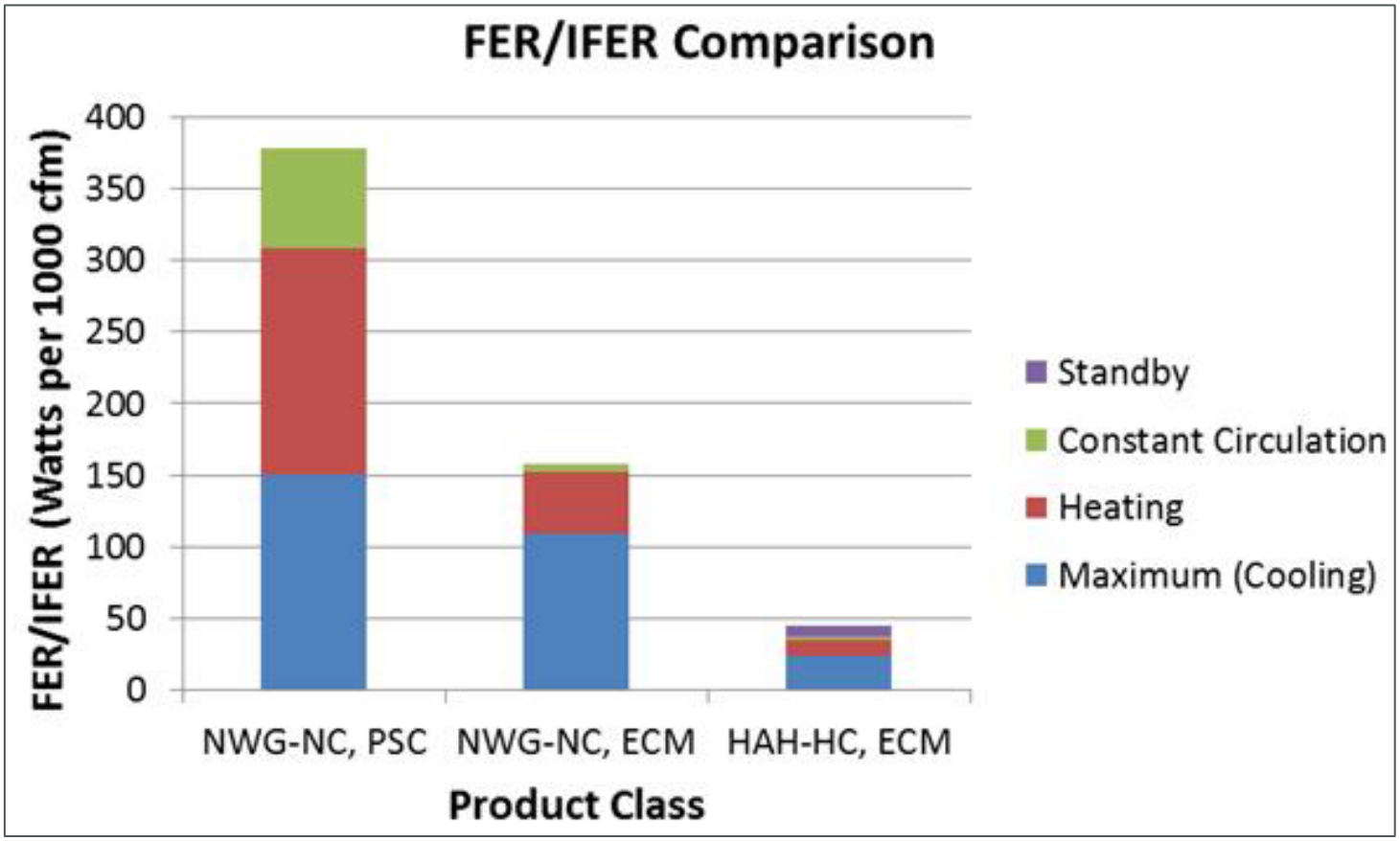
Function	Power (W)	Annual Operating Hours	Annual Energy Consumption (Wh)
Cooling	400	640	256,000
Heating	150	830	124,500
Constant-Circulation	80	400	32,000
Standby	11	6,890	75,790
Total		8,760	488,290

$$IFER = \frac{Annual\ Energy\ Consumption}{Airflow\ at\ Max\ Operating\ Point \times Total\ Annual\ Operating\ Hours} \times 1000$$

$$IFER = \frac{488,290\ Wh}{1{,}240\ cfm \times 8{,}760\ hours} \times 1000 = \mathbf{45\ Watts\ per\ 1000\ cfm}$$

FER/IFER Comparison

Contribution to Consumption by Function



- Non-weatherized, non-condensing gas furnace fan with a PSC Motor (NWG-NC, PSC).
- Non-weatherized, non-condensing gas furnace fan with an ECM (NWG-NC, ECM).
- Hydronic air handler (heating and cooling) fan with an ECM (HAH-HC, ECM).

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Sampling Plan for Residential Furnace Fans

- DOE proposes to create a new section, 10 CFR 429.55, for sampling plan specifications for manufacturers to determine certified ratings.

- DOE proposes to adopt the same statistical sampling procedures that are applicable to residential furnaces. (10 CFR 429.18 and 429.11)

- DOE believes product variability and measurement repeatability associated with the electrical energy consumption measurements proposed for rating residential furnace fans are similar to those associated with electrical energy consumption measurement required for residential furnaces.

Request For Comment

Operating Hour Estimates

DOE requests comments on whether the sampling plan procedures for residential furnaces are appropriate for representation and certification of residential furnace fans measures of electrical energy consumption.

(Issue 10)

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4. Fan Efficiency Rating (FER)
5. Rating Examples
6. Certification, Compliance & Enforcement
7. Closing Remarks

Closing Remarks and Comments

- Closing Remarks
  - At this time, DOE welcomes any additional remarks or questions from interested parties on the test procedure NOPR for residential furnace fans.

- DOE specifically invites comment on:
  - The proposed test procedure;
  - The numbered issues on which DOE seeks comments presented in issue boxes throughout the presentation.

DOE Seeks Comments on its Proposal

- In all correspondence, include all of the following:
  - Test Procedure for Residential Furnace Fans
  - Docket Number: EERE-2010-BT-TP-0010
  - Regulatory Identification Number (RIN):1904-AC21

- Contact Information

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Comment period closes: July 30, 2012

Backups

Definitions

- Residential furnace fan means an electrically-powered device used in residential central heating, ventilation, and air-conditioning (HVAC) systems for the purpose of circulating air through duct work.

- Hydronic air handler means a furnace designed to supply heat through a system of ducts with air as the heating medium, in which heat is generated by hot water flowing through a hydronic heating coil and the heated air is circulated by means of a fan or blower.

- Airflow-control settings means any distinct operating mode characterized by nominal fan speed or airflow that a furnace fan is programmed or wired to achieve when installed in accordance with manufacturer instructions and which is often designated for performing a specific HVAC function (e.g., cooling, heating, or constant-circulation).

- Default airflow-control settings are the airflow-control settings that can be achieved in the factory-set control system configuration (i.e., without manual adjustment other than interaction with a user-operable control such as a thermostat).

Definitions

- External static pressure (ESP) means the difference between the fan total pressure at the air outlet and the total pressure at the air inlet less velocity pressure at the air outlet of an HVAC product containing a furnace fan when operating and installed in accordance with the manufacturer's instructions. External static pressure does not include the pressure drop across appurtenances internal to the HVAC product.

- Determination is complete set of measurements for a particular point of operation for a fan, as defined by ANSI/AMCA 210-07. For this notice, a complete set of measurements at a particular point of operation includes airflow, electrical consumption, and ESP.

Definitions

- Active mode means any mode in which the HVAC product is connected to the power source and circulating air through duct work.
- Standby mode means the mode during which the HVAC product is connected to the power source and the furnace fan is not activated.
- Off mode means the mode during which the HVAC product is not powered.
- Seasonal off switch means the switch on the HVAC product that, when activated, results in a measurable change in energy consumption between the standby and off modes.

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8. Piggs, S., “Central Electricity Use by New Furnaces: A Wisconsin Field Study” (2003) (URL: http://www.doa.state.wi.us/docview.asp?docid=1812).
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12. Ecotope, “Summary of Results of Field Testing on Newer NEEM Homes With Mastic Duct Systems,” memorandum to Tom Hewes and Brady Peeks of Oregon Department of Energy (June 10, 2006).
13. Baylon, D. and B. Davis, "Summary of NEEM Manufactured Home Field Data.“ Submitted to Oregon Department of Energy (Jan. 2009) (URL: http://www.nwcouncil.org/energy/rtf/meetings/2009/04/Draft%202008%20NEEM%20Study_040608.pdf).

Fan Efficiency Rating

Operating Hours Methodology: Heating

Single-Stage: $$HH_{ss} = y \times \frac{(WF_{heat} \times HE_{Annual})}{Q_{in}} = \mathbf{830\ hours}$$

Multi-Stage: $$HH_m = \frac{830}{HCR}$$

Variable	Description	Value	Primary Source
y	Ratio of blower on-time to average burner on-time	1.39	2007 DOE Furnace Database
WF_{Heat}	Heating weather adjustment factor	1.04	NOAA heating degree day (HDD) per Census Division
HE_{Annual}	Average annual heating energy use	49.8 MMBtu/year	EIA RECS 2005
Q_{in}	Average input heat capacity	86.8 kBtu/hour	2001 Shipment Data and 2010 AHRI Directory
HCR	Heating capacity ratio (lowest output capacity to highest output capacity)	Model Specific	Product Literature

Fan Efficiency Rating

Operating Hours Methodology: Cooling

$$CH = y_C \times \frac{(WF_{cool} \times CE_{Annual} \times SEER)}{Q_{in}} = \mathbf{640\ hours}$$

Variable	Description	Value	Primary Source
y_C	Ratio of blower on-time to average compressor on-time	1.12	Product Literature
WF_{Cool}	Cooling weather adjustment factor	0.89	NOAA cooling degree day (CDD) per Census Division
CE_{Annual}	Average annual cooling energy use	2025 kWh/year	EIA RECS 2005
SEER	Seasonal energy efficiency ratio	11.06	AEO 2008
Q_{in}	Average cooling capacity	34,884 Btu/h	2007-2010 AHRI Shipment Data

Fan Efficiency Rating

Operating Hours Methodology: Circulation

How Often is Continuous Fan Used?	Combined Data from Studies		Assumed Average Number of Hours	National Weighted Average Percentage of Consumers (%)	National Weighted Average Number of Hours
	Number of Homes	Percentage (%)			
No continuous fan	69	68%	0	89%	0
Year-round	14	14%	7290	5%	365
During heating season	4	4%	1097	1%	16
During cooling season	4	4%	541	1%	8
Other (some continuous fan)	10	10%	365	4%	13
Total	101	100%	-	100%	**401**

- Assumed hours for each response estimated using total annual hours (8,760), furnace fan operating hour estimates, and June 2010 CAC test procedure NOPR heating/cooling season hour estimates. (June 2, 2010, 75 FR 31224, 31270)
- DOE estimates that the fraction of consumers that use constant circulation is 50 percent less in the North and South Hot Dry region and 90 percent less in the South Hot Humid region than the percentages reported in the survey data.
- 65 percent of furnace fans are located in the North and South Hot Dry region, while 35 percent are in the South Hot Humid region.

Fan Efficiency Rating

Operating Hours Methodology: Circulation

- Assumed Average Number of Circulation Hours per Response:
  - $"Not\ used" = \mathbf{0}$
  - $"Year - round" = Total\ Annual\ Hours - CH - HH$
    $= 8760 - 640 - 830 = \mathbf{7290}$
  - $"During\ Heating\ Season" = (Heating\ Season\ Hours - HH) \times use\ factor$
    $= (5216 - 830) \times 0.25 = \mathbf{1097}$
  - $"During\ Cooling\ Season" = (Cooling\ Season\ Hours - CH) \times use\ factor$
    $= (2805 - 640) \times 0.25 = \mathbf{541}$
  - $"Some" = Total\ Annual\ Hours \times use\ factor$
    $= 8760 \times 0.05 = \mathbf{365}$
- National Weighted Average Percentage (NWAP) of Consumers:
  - $NWAP = \sum_{region} adjustment \times population \times survey\ percentage$
    $= (0.50 \times 0.65 \times 0.14) + (0.10 \times 0.35 \times 0.14) = \mathbf{0.05}$

Sampling Plan for Residential Furnace Fans

- Statistical sampling procedures for residential furnaces (10 CFR 429.18)
  - FER or IFER shall be greater than or equal to the higher of:
    1. The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

and, $\bar{x}$ is the sample mean; n is the number of samples; and x_i is the i^{th} sample; or

    2. the upper 97-1/2 percent confidence limit (UCL) of the true mean divided by 1.05, where:

$$UCL = \bar{x} + t_{0.975}\left(\frac{s}{\sqrt{n}}\right)$$

And $\bar{x}$ is the sample mean; s is the sample standard deviation; n is the number of samples; and $t_{0.975}$ is the t statistic for a 97.5% one-tailed confidence interval with n-1 degrees of freedom