Appliance Standards and Rulemaking Federal Advisory Committee
Commercial and Industrial Fans and Blowers Working Group
Term Sheet
September 3, 2015 (edited September 24, 2015)

Background

On April 1, 2015, DOE issued a Notice of Intent to Establish the Fans and Blowers Working Group to negotiate a Notice of Proposed Rulemaking (NOPR) for energy conservation standards and test procedures for fans and blowers. 80 FR 17359. This working group is established under the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) in accordance with the Federal Advisory Committee Act and the Negotiated Rulemaking Act. The purpose of the working group was to discuss and, if possible, reach consensus on the scope of the rulemaking, certain key aspects of a proposed test procedure, and proposed energy conservation standard for fans and blowers, as authorized by the Energy Policy and Conservation Act (EPCA) of 1975, as amended. The working group was to consist of representatives of parties having a defined stake in the outcome of the proposed standards, and to consult as appropriate with a range of experts on technical issues.

DOE received 25 nominations for membership. Ultimately, the working group consisted of 25 members; including one member from ASRAC and one DOE representative (see Appendix A). The working group met sixteen times. The meetings were held on May 5, May 6, May 18, May 19, June 3, June 4, June 22, June 23, July 21, July 22, August 4, August 5, August 6, September 1, September 2, and September 3, 2015. The working group successfully reached consensus on certain aspects related to scope, test procedures, metric, and aspects of the energy conservation standards related to certification. This document includes the working group's recommendations to ASRAC on the energy conservation standards and test procedure and metric-related recommendations. Appendix E includes items where the working group did not reach consensus.

Scope

Fan Categories "in"
Recommendation 1.

- The scope of the test procedure and energy conservation standards recommended as part of this Working Group will include the following categories of fans: (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.
- Equipment classes are discussed under Recommendation 30.

Vote results: Consensus (24 yes - 0 no – 0 abstention – 1 absent) on 7/21/2015

Fan and Impeller Categories "out"
Recommendation 2.

- The scope of the test procedure and energy conservation standards recommended as part of this Working Group will exclude the following:
    - (1) Fans of following categories, either standalone or embedded in larger pieces of equipment:
        - Radial housed unshrouded fans with diameter less than 30 inches or a blade width of less than 3 inches;
        - Safety fans as defined in Appendix D.
        - Circulating fans;
        - Induced flow fans;
        - Jet fans;
        - Cross flow fans[1]; as well as

    - (2) Fans embedded in:
        - Regulated Central Air Conditioners and Heat Pumps (Single-Phase, <65,000 Btu/h)
        - Regulated Commercial Air Conditioners and Heat Pumps that are Three-phase and less than <65,000 Btu/h (Air-Cooled)
        - Regulated Consumer Furnaces
        - Transport refrigeration (i.e., Trailer refrigeration, Self-powered truck refrigeration, Vehicle-powered truck refrigeration, Marine/Rail container refrigerant), and fans exclusively powered by internal combustion engines;
        - Vacuums
        - Fans exclusively embedded in Heat Rejection Equipment (as characterized by the Cooling Tower Institute) as:
            - Heat Rejection Equipment is defined as follows:
                - Packaged evaporative open circuit cooling towers: a device which rejects heat to the atmosphere though the direct cooling of a water stream to a lower temperature by partial evaporation.
                - Evaporative field erected open circuit cooling tower: a structure which rejects heat to the atmosphere though the direct cooling of a water stream to a lower temperature by partial evaporation.
                - Packaged evaporative closed circuit cooling towers: a device which rejects heat to the atmosphere though the indirect cooling of a process fluid stream in an internal coil to a lower temperature by partial evaporation of an external recirculating water flow.
                - Evaporative field erected closed circuit cooling tower: a structure which rejects heat to the atmosphere though the

[1] WG to provide clarification of cross flow fan exclusion.

indirect cooling of a process fluid stream to a lower temperature by partial evaporation of an external recirculating water flow.
    - Packaged evaporative condensers: a device which rejects heat to the atmosphere though the indirect condensing of a refrigerant in an internal coil by partial evaporation of an external recirculating water flow.
    - Field erected evaporative condensers: a structure which rejects heat to the atmosphere though the indirect condensing of a refrigerant in an internal coil by partial evaporation of an external recirculating water flow.
    - Packaged air cooled (dry) coolers: a device which rejects heat to the atmosphere from a fluid, either liquid, gas or mixture thereof, flowing through an air-cooled internal coil.
    - Field erected air cooled (dry) coolers: a structure which rejects heat to the atmosphere from a fluid, either liquid, gas or mixture thereof, flowing through an air-cooled internal coil.
    - Air cooled steam condensers: a device for rejecting heat to the atmosphere through the indirect condensing of steam inside air-cooled finned tubes.
    - Hybrid (water saving) versions of all of the above listed equipment that contain both evaporative and air cooled heat exchange sections.
- If DOE can find a regulatory mechanism within its legal requirements, fans embedded in air curtains shall be excluded from the test procedures and standards established by this term sheet.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 08/06/2015, edited on 09/02/2015

Supply and Condenser Fans Embedded in Regulated Equipment, Where the DOE Metric Captures the Energy Use of Such Fans
Recommendation 3.

- For a supply or condenser fan that is embedded in a regulated piece of equipment listed in Appendix B (i.e., select equipment for which the DOE metric captures the energy use of the supply fans and condenser fans):
    - (1) if the fan is embedded solely in regulated equipment listed in Appendix B, the fan is exempt from the test procedure and energy conservation standards recommended as part of this Working Group.
    - (2) if the fan is also embedded in equipment not listed in Appendix B or as a standalone fan, that fan is subject to the test procedure and energy conservation standards recommended as part of this Working Group.

- The fans embedded in regulated equipment as listed in Appendix B will not be considered for any additional test procedures, certifications, standards or enforcement as part of the fans and blowers rulemaking.
- The working group recommends that the metric and test procedures for regulated equipment for which the DOE metric partially includes the energy use of supply and condenser fans, be considered for modifications during their next round of rulemaking to include the full supply and condenser fan energy use in a modified metric. DOE will initiate the test procedure rulemakings early (best efforts for at least one year). As part of each of these rulemakings, DOE will consider part-load performance and operating points.
- As part of implementing this term sheet, DOE will propose a way to distinguish fans falling under (1) (e.g. permanent marking/labeling/listing).

Vote results: Consensus (18 yes – 0 no – 5 abstention – 1 absent) on 09/03/2015

Fans Embedded in Non-Regulated Equipment, and/ or Embedded in Regulated Equipment Other Than Listed in Appendix B, and/or Any Fans That Are Not Supply and Condenser Fans in Regulated Equipment listed in Appendix B
Recommendation 4.

- If DOE can find a way to enforce this regulatory approach within its statutory framework, the approach for fans embedded in non-DOE regulated equipment, and/or embedded in regulated equipment other than listed in Appendix B, and/or fans that are not supply or condenser fans in DOE-regulated equipment listed in Appendix B will be as follows:
    - The fan will be certified over its standalone operating range;
    - The test procedure will be as discussed in Recommendation 8.;
    - The first manufacturer of a testable configuration will be responsible for certifying the standalone fan performance to DOE.
    - If a manufacturer purchases such a fan in a standalone configuration, that manufacturer must ensure that the design operating range (or design point) of the embedded fan is within the certified operating range of the standalone fan, and disclose the design operating range (or design point) of the embedded fan to the end-user.

Vote results: Consensus (19 yes - 3 no – 1 abstention – 1 absent) on 09/03/2015
Members voting no: UTC Carrier, Trane/IR, Daikin/Goodman

Scope Refinement
Recommendation 5.

- The scope of the test procedure and energy conservation standards recommended as part of this Working Group will only apply to the fan operating points with the following characteristics:
    - Fan shaft power equal or greater than 1 BHP fan shaft power; and
    - Fan airpower equal or less than 150 HP (static airpower for unducted fans, total airpower for ducted fans, see Appendix C).

Vote results: Consensus (23 yes – 0 no – 1 abstention – 1 absent) on 7/22/2015

Test Procedure and Metric

Metric
Recommendation 6.

- The metric used in the regulation will be the fan electrical input power (FEP) and the fan energy index (FEI) will be allowed for representation. The FEI will be calculated using the FEP of a fan that exactly meets the standard (FEP_{STD}) which will be fixed in time to the first level established by the regulation. Both the FEP and the FEI will be represented values determined according to the DOE test procedure and sampling plan and certified to DOE.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 07/21/2015

Testing Standalone Fans (Non-Embedded Fans)
Recommendation 7.

- The fan test procedure should generally be based on AMCA 210 (latest version available at the time of publication) for determining bare-shaft fan performance and performance of non-embedded fans. The following installation types will be used for each fan category: (1) axial cylindrical housed (D); (2) panel (A); (3) centrifugal housed, excluding inline and radial (B); (4) centrifugal unhoused, excluding inline and radial (A); (5) Inline and mixed-flow (B); (6) Radial housed (D); and (7) Power Roof Ventilators (A).
- The testable configuration for each equipment class of non-embedded fans shall be defined in the test procedure and include, at a minimum and where appropriate, the following basic parts: an impeller, a shaft, bearings, and a structure or housing.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 08/04/2015, edited on 09/02/2015

Recommendation 8.

Testing Embedded Fans Outside of Equipment

- Testing of embedded fans will be performed outside of the equipment in a standalone fan testable configuration. If necessary, non-impeller components of the fan that are geometrically similar to the ones used by the fan as embedded in the larger piece of equipment will be used to complete the fan testable configuration.

Vote results: Consensus (22 yes – 0 no – 0 abstention – 3 absent) on 09/02/15

Direct Measurement and Calculation-based Method for Non-Embedded Fans
Recommendation 9.

- The primary focus of the test procedure rulemaking will be to represent the fan electrical input power (FEP). The FEP shall be determined either through:
    - direct measurement of the fan electrical input power (not applicable to bare-shaft fans), and/or
    - measurement of the fan's shaft input power and the combination of default values to be incorporated in the FEP for bare-shaft fans, fans sold with regulated motors[2], fans sold with AO motors[3], and fans sold with regulated motors and dynamic continuous controls[4].

  The default values to use in the calculation of the FEP shall be included in the notice of proposed rule for the test procedure. The test procedure will also specify the calculation of the FEI.

Vote results:

Bare shaft fans: Consensus (23 yes – 1 no – 0 abstention – 1 absent) on 08/04/2015
Bare shaft fans + Motor: Consensus (23 yes – 1 no – 0 abstention – 1 absent) on 08/04/2015
Bare shaft fans + Motor + controls: Consensus (23 yes – 1 no – 0 abstention – 1 absent) on 08/04/2015
Member voting no (all three votes): Morrison Products

Horsepower of the Default Motor used in FEP Calculation for Bare-shaft Fans
Recommendation 10.

- In this rulemaking, the horsepower of the default motor will be the horsepower listed in table 5 of 10 CFR 431.25 that is equal to either: 120 percent of the fan shaft input power at a given operating point, or equal to the next highest horsepower greater than 120 percent of the fan shaft input power at a given operating point.

Vote results: Consensus (22 yes – 1 no – 0 abstention – 2 absent) on 09/02/15
Member voting no: Morrison Products

Default Values for Motor Full load Efficiency used in FEP Calculation for Bare-shaft Fans
Recommendation 11.

- In this rulemaking, at a given motor horsepower the full load efficiency of the default motor used in the FEP calculation for a bare-shaft fan will be based on the minimum of the motor full load nominal efficiency from table 5 of 10 CFR 431.25 for four pole motors and across all enclosures.

[2] Regulated under 10 CFR 431.25
[3] Air-Over (AO) motor which otherwise meet all nine characteristics from 10 CFR 431.25(f)
[4] Variable speed controls or dynamic continuous control: any device that adjusts the speed of the fan continuously over the fan's operating speed range in response to incremental changes in the required fan output airflow during its operation

Vote results: Consensus (22 yes – 1 no – 1 abstention – 1 absent) on 09/02/2015,
Member voting no: Morrison Products

Default Values for Motor Full load Efficiency used in FEP Calculation for Fans Sold with Regulated Motors
Recommendation 12.

- In this rulemaking, the full load efficiency of the default motor used in the FEP calculation for a fan sold with a regulated motor[5] will be based on the motor full load nominal efficiency from table 5 of 10 CFR 431.25 for the motor horsepower and pole configuration identical to that of the fan's motor.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 08/04/2015

Default Values for Motor Full load Efficiency used in FEP Calculation for Fans Sold with Air Over Motors (AO)
Recommendation 13.

- In this rulemaking, the full load efficiency of the default motor used in the FEP calculation for a fan sold with a AO motor[6] will be based on the motor full load nominal efficiency from table 5 of 10 CFR 431.25, and by using the full load efficiency corresponding to the following number of NEMA bands below the values in table 5 of 10 CFR 431.25.

[5] Regulated under 10 CFR 431.25
[6] Air-Over (AO) motor which otherwise meet all nine characteristics from 10 CFR 431.25(f)

AO Electric Motor Full Load Efficiency (NEMA bands below Table 5 of 10 CFR 431.25 for motors)				
Motor Horsepower	**Pole configurations**			
	2	**4**	**6**	**8**
1	3	7	7	3
1.5	3	7	7	3
2	3	7	7	3
3	3	7	7	3
5	3	7	7	3
7.5	3	5	2	1
10	3	5	2	1
15	3	5	2	1
20	3	5	2	1
25	3	5	2	1
30	3	3	2	3
40	3	3	2	3
50	3	3	2	3
60	3	3	2	3
75	3	3	2	3
100	3	3	2	3
125	3	3	2	3
150	3	3	2	3
200	3	3	2	3
250	3	3	2	3

Appendix E provides the corresponding motor full load efficiencies for enclosed and open AO motors.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 08/04/2015, edited on 09/02/2015.

Default Values for Transmission Efficiency
Recommendation 14.

- In this rulemaking, the efficiency of the default transmissions used in the FEP calculation will be based on the medium efficiency curve in AMCA 203 using the following equation: 0.96 * (1-exp(-275*BHP)^0.19); where BHP is the fan shaft input power in horsepower.
- In this rulemaking, the efficiency of the default transmissions used in the FEP calculation for direct driven fans is 1.

Vote results: Consensus (23 yes – 1 no – 0 abstention – 1 absent) on 08/04/2015
Member voting no: ebm-papst Inc.

Default Control Losses Determination
Recommendation 15.

- In this rulemaking, the default part load losses of the motor and controls at a given operating point i shall be determined by multiplying the motor default full load losses by the following polynomial equation:

$$z_i = (a \times x_i^2 + b \times x_i + c)$$

a,b,c = coefficients based on the horsepower of the motor with which the fan is being rated,

Motor Horsepower (hp)	Coefficients for Motor and Control Part Load Loss Factor (z_i)		
	A	**b**	**c**
≤5	-0.4658	1.4965	0.5303
>5 and ≤20	-1.3198	2.9551	0.1052
>20 and ≤50	-1.5122	3.0777	0.1847
>50	-0.8914	2.8846	0.2625

Where x_i is the load fraction for the motor at operating point i (percent), calculated as follows:

$$x_i = \frac{BHP_i}{\eta_{T,i}} \times \frac{1}{MotorHP}$$

Where:

BHP_i = shaft input power (hp) at operating point i;
MotorHP = the motor horsepower (hp) as determined in accordance with Recommendation 10., Recommendation 11., Recommendation 12., and Recommendation 13. ; and
$\eta_{T,i}$ = default transmission efficiency at rating point i (percent) as determined in accordance with Recommendation 14.

Note: this equation is valid up to a limit to be validated (e.g. x_i =1.2). Above that limit, the losses shall be capped.

Vote results: Consensus (22 yes – 0 no – 0 abstention – 3 absent) on 09/02/15

Credit for Fans with Controls
Recommendation 16.

At a given operating point P_1 (pressure) and Q_1 (flow):

- FEP_{STD} is calculated based on a default bare-shaft fan + motor + belt configuration, includes belt losses at P_1 and Q_1
- $FEP_{fan\_control}$ includes control losses at P_1 and Q_1 and a credit for use of dynamic continuous controls.

Vote results: Consensus (20 yes – 0 no – 2 abstention – 3 absent) on 09/02/2015

Note: During the September 2, 2015 meeting, the following was discussed: :

- AMCA suggested a credit that would be equal to the controls losses. Others recommended a credit greater than the control losses.
- The European example of the credit as a function of electrical input power was also mentioned.

Test Speed and Use of the fan laws
Recommendation 17.

- For a bare shaft fan with a given diameter, the fan shall be tested at:
  - A single speed if using the fan laws to determine the performance of the fan at other speeds, defined as follows:
    - for fans other than fans sold with a multispeed motor and direct driven: the fan will be tested at its average speed of operation. The average speed of operation is the average of the maximum and the minimum speed for which the fan is offered for sale,
    - for fans sold with a multispeed motor and direct driven: the fan will be tested at its average speed of operation if available for operation, or at its next lowest operating speed lower than the average speed of operation. The average speed of operation is the average of the maximum and the minimum speed for which the fan is offered for sale.
  - at each speed offered for sale if not using the fan laws to determine the performance of the fan at other speeds.

  At each tested speed, no less than a number of points to be determined by DOE that are equally spaced (flow) determinations shall be made from shut off to free delivery. Operating conditions and performance between determinations shall be based on a moving polynomial defined by DOE. Working Group members will submit a recommendation for the number of points to the docket that will be considered by DOE when determining the number of points.

Vote results: Consensus (21 yes – 0 no – 1 abstention – 3 absent) on 09/02/2015

<u>Energy Conservation Standards</u>

Calculation of the Standard Level FEP for standalone fans (FEP_{STD})

Recommendation 18.

- The maximum allowable fan electrical input power (FEP_{STD}) at each declared operating point i (Q_i, P_i) shall include: the fan shaft input power corresponding to a fan with a fan efficiency

equal to $\eta_{STD,i}$; belt losses as calculated using the default belt efficiency curve ($\eta_{T,i}$); and default motor losses ($L_{M,i}$) at that operating point.

Where:

$FEP_{STD,i}$ = maximum allowable fan electrical input power kW at operating point i;
Q_i = flow (cfm) at operating point i;
P_i = total pressure for ducted fans / static pressure for unducted fans (in.wg) at operating point i;
$\eta_{STD,i}$ = minimum fan total efficiency for ducted fans / minimum fan static efficiency for unducted fans (%) at operating point i as calculated in accordance with Recommendation 19;
$\eta_{T,i}$= default transmission efficiency (percent) at operating point i as calculated in accordance with Recommendation 14;
$L_{M,i}$ =default electric motor losses (hp) at operating point i as calculated based on Recommendation 11.

Note: On 08/13/2015 the WG discussed the possibility an alternative calculation of the FEP_{STD} for fans sold with motors and controls.
On 9/2/15 the WG resolved calculation of FEP_{STD} for fans with motors and controls (See Recommendation 16.)

Vote results: Consensus (24 yes - 1 no – 0 abstention – 0 absent) on 08/05/2015
Member voting no: Morrison Products

Fan Total and Static Efficiency Equation
Recommendation 19.

- The minimum fan total efficiency for ducted fans / minimum fan static efficiency for unducted fans (%) at operating point i shall be calculated in accordance the following equation:

$$\eta_{STD,i} = \eta_{target} \frac{Q_i \times P_i}{(Q_i + Q_0)(P_i + P_0)}$$

  Where:

  $\eta_{STD,i}$ = minimum fan total efficiency for ducted fans / minimum fan static efficiency for unducted fans (percent) at operating point i ;
  Q_i= flow (cfm) at operating point i;
  P_i = total pressure for ducted fans, static pressure for unducted fans (in.wg) at operating point i;
  Q_0 = flow constant, as established in Recommendation 20;
  P_0 = pressure constant, as established in Recommendation 21; and
  η_{target}= constant used to establish the efficiency level to be set by this rulemaking.

Note: all pressures refer to standard air density.

Vote results: Consensus (25 yes – 0 no – 0 abstention – 0 absent) on 08/05/2015

Value of Q_0
Recommendation 20.

- Q_0 shall be equal to 250

Vote results: Consensus (22 yes – 0 no – 3 abstention – 0 absent) on 08/05/2015

Value of P_0
Recommendation 21.

- P_0 shall be equal to 0.4

Vote results: Consensus (22 yes – 0 no – 3 abstention – 0 absent) on 08/05/2015Represented Values

Use of the fan laws across sizes
Recommendation 22.

- The use of the fan laws will be allowed to determine the represented values of FEP and FEI for geometrically similar fans[7] as follows:
    - If a manufacturer offers geometrically similar fans at more than three impeller diameters for sale, the manufacturer shall test at least three diameters for bare shaft performance over the range and use the fan laws to calculate operating points (and performance) for any larger diameter fans within the range offered sale based on testing of the smaller geometrically similar bare shaft fans;
    - For custom fans (those offered in selection software but not in catalogues) and for those geometrically similar fans offered for sale at three or less impeller diameter, the manufacturer shall test at least one diameter for bare-shaft fan performance over the range and use the fan laws to calculate operating points (and performance) for any larger diameter fan within the range offered sale based on testing of the smaller bare shaft fan.

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 08/04/2015

Represented Values
Recommendation 23.

- When testing is used to establish the rating of a basic model, a minimum of 1 unit shall be tested and the tested result shall be no greater than the represented value ($FEP_{STD} \geq FEP_{Rating} \geq FEP_{TEST}$). When using an AEDM to establish the rating of a basic model, the value resulting from the AEDM shall be no greater than the represented value ($FEP_{STD} \geq FEP_{Rating} \geq FEP_{AEDM}$). Conservative rating will be allowed.

[7] The definition of geometrically similar will be based on AMCA 211 Annex A which states that most design dimensions shall be proportional within +/- 1 percent (with listed exceptions).

Vote results: Consensus (22 yes – 0 no – 0 abstention – 3 absent) on 09/02/2015

AEDM minimum number of models to be tested
Recommendation 24.

- The minimum number of basic models that shall be tested to validate an AEDM shall be as follows (example):
  - (1) At least 2 compliant basic models selected for testing per equipment class for which the AEDM is to be applied.
  - (2) If an AEDM is used to rate models that simulate the wire-to-air test then the models used to validate the AEDM pursuant to bullet (1) should be tested with the full wire-to-air.

Vote results: Consensus (21 yes – 0 no – 1 abstention – 3 absent) on 09/02/2015

Validation of an AEDM
Recommendation 25.

- The predicted FEP using the AEDM may not be more than 5% less than the FEP determined from the test according to the DOE test procedure for the basic models used to validate an AEDM.

Vote results: Consensus (20 yes – 0 no – 2 abstention – 3 absent) on 09/02/2015

Certification
Recommendation 26.

- DOE will investigate whether manufacturers can be allowed to use selection software in lieu of certification to DOE. Representations would be allowed to be made for any model available in the selection software. The selection software would be available on the DOE website.
- If a manufacturer does not have selection software or DOE cannot find a viable way to administer its certification by accepting selection software, the manufacturer would have to submit the certification of the operating range for each individual model distributed in commerce to DOE. (either in tabular format or equations/curves)

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 09/03/2015

Recommendation 27.

- Manufacturers would be required to submit the general information in 429.12, including the manufacturer/model which would encompass the bare shaft fan/impeller

manufacturer and model number, the motor manufacturer and model number (where applicable), and controls/driver manufacturer and model number (where applicable).

- At least the following public equipment specific information will required to be certified for each manufacturer-declared operating point: fan operating flow (CFM), fan operating pressure (in.wg. static and total for unducted and ducted fans, respectively), FEP (kW), FEI, fan operating speed (RPM) and fan shaft input power (HP) for fans using the calculation-based/default-value method and relying on the shaft input power measurement.
- At least the following public equipment specific information will required to be certified by each fan manufacturer: fan maximum operating speed.
- At least the following non-public equipment specific information will be provided: rating method (e.g. wire-to-air/direct measurement test or calculation-based/default value method, use of the fan laws or not).

Vote results: Consensus (24 yes – 0 no – 0 abstention – 1 absent) on 09/03/2015

This term sheet has been approved by the ASRAC Fans and Blowers working group by consensus vote on 09/03/2014 (18 yes – 2 no – 0 abstention - 5 absent). It can now be passed to ASRAC for consideration. It should be noted that the exact language in this term sheet may be modified when implemented by DOE as regulatory text, but the intent should remain the unchanged.

Members voting no on the Entire Term sheet: Trane/IR and AHRI

Appendix A—Members

U.S. Department of Energy—ASRAC
Fans and Blowers Working Group

Ashley Armstrong	U.S. Department of Energy
Mark Bublitz	The New York Blower Company
Larry Burdick	SPX Cooling Technologies / CTI
Duane Daddis	United Technologies/Carrier
Steve Dikeman	AcoustiFLO LLC
Gary Fernstrom	Pacific Gas & Electric Company, San Diego Gas & Electric Company, Southern California Edison, and Southern California Gas Company
Mark Fly	AAON, Inc.
Dan Hartlein	Twin City Companies, Ltd
Armin Hauer	ebm-papst Inc
Nicholas Howe	Carnes Company
Diane Jakobs	Rheem Manufacturing Company
David Johnson	Berner International Corp
Joanna Mauer	Appliance Standards Awareness Project
Paul Lin	Regal Beloit Corporation
Donald McNeil	Buffalo Air Handling Company
Laura Petrillo-Groh	Air-conditioning, Heating, and Refrigeration Institute (AHRI)
Aniruddh Roy	Daikin/Goodman
Geoff Sheard	AGS Consulting LLC
William Smiley	Smiley Engineering LLC representing Trane/IR
Wade Smith	Air Movement and Control Association International
Louis Starr	Northwest Energy Efficiency Alliance
Gregory Wagner	Morrison Products
Meg Waltner	Natural Resources Defense Council
Stephen R. Wiggins	Newcomb & Boyd
Michael Wolf	Greenheck

Appendix B—Regulated Equipment for which the DOE metric accounts for the energy use of the supply and condenser fans.

- Air-cooled commercial AC/HP, 5.5 - 63.5 tons (CUAC/CUHP)
- Water-cooled and Evaporatively-cooled AC and Water-source HP
- Commercial Single Package Vertical ACs and Single Package Vertical HPs
- PTACs and PTHPs
- Computer Room ACs
- Commercial VRFs

Appendix C—Ducted and Unducted Fans

- The following fan types are considered Ducted for the purposes of this test procedure and regulation:
    - Axial cylindrical housed
    - Centrifugal housed, excluding inline and radial
    - Inline and mixed flow
    - Radial housed
- The following fan types are considered Unducted for the purposes of this test procedure and regulation:
    - Panel
    - Centrifugal unhoused, excluding inline and radial
    - Power roof ventilators

Appendix D—Definitions

Safety Fan Definition

The definitions presented in this appendix are subject to potential edits necessary to accomplish the same intent.

Safety fan:

The current working definition is based on the European definition:

Fans designed for use in applications requiring extra safety measures, such as:

a) those designed to operate in potentially explosive atmospheres (ATEX fans);

b) those designed for emergency use only, at short-time duty, with regard to fire safety requirements (e.g. smoke extraction fans, emergency reversible tunnel fans);

c) those designed specifically to operate where the temperature of gases being moved exceed 200ºF; or

d) those designed for use in toxic, highly corrosive, or flammable environments with abrasive substances (e.g. NQ-1).

Appendix E—Air Over Motor (AO) Full Load efficiency

Motor Horsepower	Default Open AO Full Load Efficiency				Default TEAO Full Load Efficiency			
	Pole configurations				Pole configurations			
	2	4	6	8	2	4	6	8
1	72	75.5	70	70	72	75.5	72	70
1.5	80	77	77	72	80	77	78.5	74
2	81.5	77	78.5	82.5	81.5	77	80	80
3	81.5	81.5	80	84	82.5	81.5	81.5	81.5
5	82.5	81.5	81.5	85.5	85.5	81.5	81.5	82.5
7.5	85.5	86.5	88.5	88.5	86.5	87.5	89.5	85.5
10	86.5	87.5	90.2	89.5	87.5	87.5	89.5	88.5
15	87.5	89.5	90.2	89.5	88.5	88.5	90.2	88.5
20	88.5	89.5	91	90.2	88.5	89.5	90.2	89.5
25	89.5	90.2	91.7	90.2	89.5	90.2	91.7	89.5
30	89.5	92.4	92.4	89.5	89.5	91.7	91.7	89.5
40	90.2	92.4	93	89.5	90.2	92.4	93	89.5
50	91	93	93	90.2	91	93	93	90.2
60	91.7	93.6	93.6	91	91.7	93.6	93.6	90.2
75	91.7	93.6	93.6	92.4	91.7	94.1	93.6	91.7
100	91.7	94.1	94.1	92.4	92.4	94.1	94.1	91.7
125	92.4	94.1	94.1	92.4	93.6	94.1	94.1	92.4
150	92.4	94.5	94.5	92.4	93.6	94.5	95	92.4
200	93.6	94.5	94.5	92.4	94.1	95	95	93
250	93.6	94.5	95	93.6	94.5	95	95	93.6

Appendix F— Additional Recommendations Discussed For Which No Consensus Was Reached

Replacement Fans
Recommendation 28.

- The Working Group agrees to exclude a method of addressing replacement fans from the term sheet and leave for DOE to resolve. The record reflects different options and opinions on replacement fans. (09/02/2015)

Default Motor Part Load Losses Determination
Recommendation 29.

- In this rulemaking, the part load motor losses at a given operating point i shall be determined by multiplying the default full load losses by the following polynomial equation:

$$y_i = -0.4508 * x_i^3 + 1.2399 * x_i^2 - 0.4301 * x_i + 0.641$$

Where x_i is the load fraction for the motor at operating point i (percent), calculated as

follows:

$$x_i = \frac{BHP_i}{\eta_{T,i}} \times \frac{1}{MotorHP}$$

Where:

BHP_i = shaft input power (hp) at operating point i;
MotorHP = the motor horsepower (hp) as determined in accordance with Recommendation 10., Recommendation 11., Recommendation 12., and Recommendation 13. ; and
$\eta_{T,i}$ = default transmission efficiency at rating point i (percent) as determined in accordance with Recommendation 14.

Note: this equation is valid up to a limit to be validated (e.g. x_i =1.2). Above that limit, the losses shall be capped.

On 9/02/15: WG decided to leave this issue to DOE to determine whether impacts justify inclusion.

Equipment Classes
Recommendation 30.

- The regulation shall use the following equipment classes:

- Axial cylindrical housed fans
- Panel fans
- Housed centrifugal fans, excluding inline fans and radial fans
- Unhoused centrifugal fans, excluding radial fans
- Inline fans and mixed flow fans
- Housed radial, shrouded impeller fans
- Power roof ventilators

Note: Supply power roof ventilators are included in the housed centrifugal fan equipment class

Vote results: No Consensus (14 yes – 7 no – 1 abstention – 3 absent) on 09/02/15
Note: No votes believe forward-curved fans should have their own equipment class

Labeling Minimum requirements

Recommendation 31.

- The following information shall be present on the label (design point known):
  - Model number
  - Serial number or Date of manufacturing
  - Design Flow (cfm), Design Pressure (wg.)(static/total for unducted/ducted fans)
  - Associated FEI
  - Maximum RPM of the fan (as declared by manufacturer)
  - Link to DOE website (URL) to the complete performance map of the fan

Vote results: No Consensus (16 yes – 7 no – 1 abstention – 1 absent) on 09/03/2015

Recommendation 32.

- The following information shall be present on the label (design point unknown):
  - Model number
  - Serial number or Date of manufacturing
  - Max RPM of the fan (as declared by the manufacturer)
  - Link to DOE website (URL) to certified operating range of the fan

Vote results: No Consensus (16 yes – 6 no – 2 abstention – 1 absent) on 09/03/2015