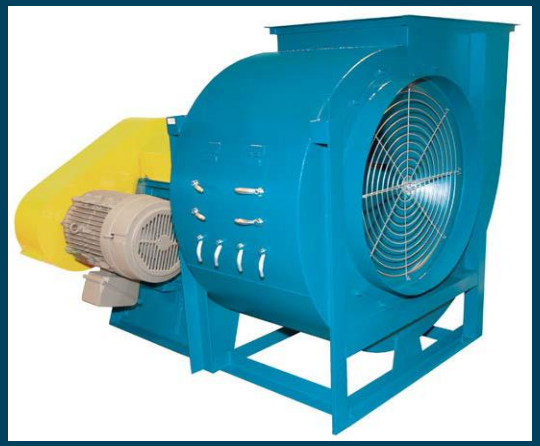


U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Update on Motor Driven Units

ESMA Conference

April 26, 2017

Jeremy Dommu

Department of Energy

Building Technologies Program

DOE Building Technologies Office

Beginning with the Energy Policy and Conservation Act of 1975, Congress has enacted a series of laws establishing federal appliance and equipment standards and the Department of Energy's (DOE) authority to develop, amend, and implement standards.

- Energy Policy and Conservation Act (EPCA) of 1975
- National Appliance Energy Conservation Act (NAECA) of 1987
- Energy Policy Act (EPAct) of 1992
- Energy Policy Act (EPAct) of 2005
- Energy Independence and Security Act (EISA) of 2007
- American Energy Manufacturing Technical Corrections Act (AEMTCA) of 2012

DOE Building Technologies Office

- The U.S. Department of Energy (DOE) Buildings Technologies Office implements minimum energy conservation standards and develops Federal Test Procedures for more than 60 categories of appliances and equipment, including electric motors and motor driven equipment such as pumps, fans, and compressors

Electric Motors

The current standards apply to:

Electric Motors, including partial motors which satisfy the following:

- single speed, induction;
- continuous duty
- squirrel cage;
- polyphase, AC, 60 hz line power;
- rated 600 volts or less;
- 2, 4, 6, or 8 pole;
- three or four digit NEMA frame size, or enclosed 56 NEMA frame
- 1- 500 hp
- NEMA Design A, B, C

The current standards do not apply to:

- air-over electric motors;
- liquid-cooled electric motors;
- submersible electric motors; and
- inverter-only electric motors.

Definitions can be found in Code of Federal Regulations at 10 CFR 431.12

The scope description can be found in Code of Federal Regulations at 10 CFR 431.25

Small Electric Motors

The current standards apply to:

Small electric motors:

- "A NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1-1987, including IEC metric equivalent motors"

Which satisfy the following:

- Open construction
- 2, 4, or 6 poles
- 0.25 – 3 hp
- Polyphase, CSCR, or CSIR

The current standards do not apply to:

- Small electric motors that are components of covered equipment

Definitions can be found in Code of Federal Regulations at 10 CFR 431.442

The scope description can be found in Code of Federal Regulations at 10 CFR 431.446

Electric Motors and Small Electric Motors

- **Test Procedure and Standards Update (Electric Motors)**

Most recent update	Notice of final rule published May 29, 2014
Current Standard	10 CFR 431 Subpart B – Nominal full-load Efficiency. Broadly equivalent to IE3 levels (Premium) except for fire pump electric motors (IE2 levels) (June 1, 2016)
Test Procedure	Appendix A to Subpart B of Part 431 - Based on IEEE 112-2004 Test Method B and CSA C390-10

- **Test Procedure and Standards Update (Small Electric Motors)**

Most recent update	Notice of final rule published March 9, 2010
Current Standard	10 CFR 431 Subpart X – Average full-load efficiency Broadly equivalent to IE3 levels (Premium) for polyphase and to IE2 levels or above for single phase motors. (March 9, 2015)
Test Procedure	10 CFR 431 Subpart X - Based on IEEE 112-2004, IEEE 114, and CAN/CSA C747.

- **Ongoing compliance, certification, and enforcement rulemaking for electric motors and small electric motors**
  - Notice of proposed rulemaking published. 81 FR 41378 (June 24, 2016)
  - Note: DOE published a pre-publication finale rule on January 11,2017 http://energy.gov/sites/prod/files/2017/01/f34/Motors%20CCE%20Final%20Rule_1-11-17%20NC%20CLN.pdf

Commercial and Industrial Pumps

The current standards apply to:

Clean water pumps of the following styles:

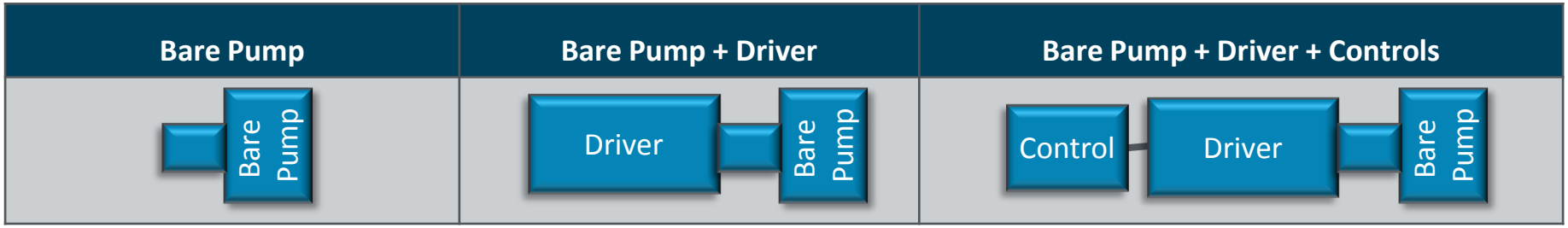
- End suction close-coupled
- End suction frame mounted
- In-line
- Radially split, multi-stage, vertical, inline diffuser casing
- Vertical turbine submersible

With additional performance and design characteristics (power, flow, head, temperature) and in all three drive configurations.

The current standards do not apply to:

- Fire pumps
- Self-priming pumps
- Prime-assist pumps
- Magnet driven pumps
- Pumps designed to be used in a nuclear facility
- Pumps designed for specific military applications

Definitions can be found in Code of Federal Regulations at 10 CFR 431.462



The scope description can be found in Code of Federal Regulations at 10 CFR 431.465

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

Commercial and Industrial Pumps

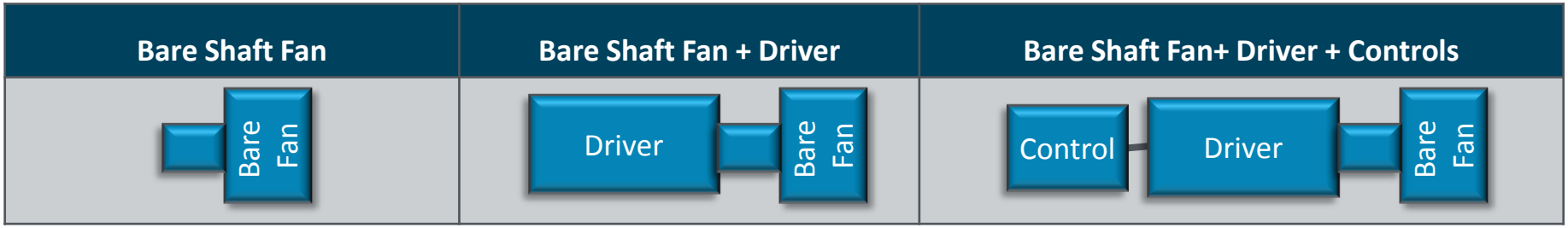
- **Test Procedure and Standard Update**

Most recent update	Notice of final rule published January 26, 2016
Current Standard	10 CFR 431 Subpart Y - Pump Energy Index (PEI) (January 27, 2020)
Test Procedure	Appendix A to Subpart Y of Part 431 - Based on HI Standard 40.6–2014

  - Negotiated Rulemaking: the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) Pumps working group met to develop recommendations for test procedure and standards
  - The standard levels were established using a "C-value" representing a constant in a three dimensional logarithmic polynomial equation, expressing pump efficiency as a function of flow and specific speed (similar to the EU No 547/2012).
  - For most pumps, the selected standard levels were set equivalent to the lower 25th percentile of efficiency, while others were set to the baseline (i.e. market minimum)
- **Metric approach for motor driven unit**
  - "Pump Energy Index" calculated as the pump electrical input power divided by the electrical input power of a minimally compliant pump (i.e. exactly compliant with the applicable standard)
  - Evaluated over a different load profile for pumps with/without controls
  - The DOE test procedure provides the flexibility to either measure (1) the electrical input power to the pump, or (2) the shaft input power of the pump and provides default values to represent the performance of a baseline motor, and controls (if any), as well as algorithms to calculate the pump electrical input power.

Commercial and Industrial Fans

- **Scope under consideration**
  - Negotiated Rulemaking: the ASRAC fans working group met to develop recommendations for fan energy conservation standards and testing
  - The fans Working Group voted on the following inclusions:
    - Axial cylindrical housed fans
    - Panel fans
    - Centrifugal housed fans
    - Inline and mixed flow fans
    - Radial housed fans
    - Power roof ventilators
  - The fans Working Group also voted a number of exemptions for fans used in some larger piece of equipment
  - Same approach as in pumps: a fan may or may not include a driver and controls



Commercial and Industrial Fans

- **Test Procedure and Standards update**

Most recent update	Term Sheet Approved September 24, 2015
Current Standard	None
Test Procedure	None - Working Group voted to use AMCA 210-16

  - Based on the working group's recommendation: the standard levels would be established using a constant in a three dimensional polynomial equation, expressing fan static or total efficiency as a function of flow and static or total pressure

- **Metric approach for motor driven unit**
  - Fan Electrical Input power (based on an approach developed by AMCA)
  - Evaluated at each manufacturer-declared operating point (every operating point must comply)
  - The approach voted on by the working group is similar to pumps:
    - provides the flexibility to either measure (1) the electrical input power to the fan, or (2) the shaft input power of the fan and provides default values to represent the performance of a baseline motor, and controls (if any), as well as algorithms to calculate the fan electrical input power.

Compressors

The proposed standards would apply to:

Certain categories of lubricated and lubricant-free air-cooled and water cooled compressors, with the following characteristics:

- Is a positive displacement rotary or reciprocating compressor
- Is driven by a brushless electric motor, which may be either fixed- or variable-speed
- Is distributed in commerce with a compressor motor nominal horsepower > 1 and < or = 500 hp
- Has a full load operating pressure (output) greater than or equal to 31 psig and < or = to 225 psig

The proposed scope description can be found in the Federal Register (81 FR 31680)

Compressors

- **Test Procedure and Standards Update**

Most recent update	Notice of proposed energy conservation standards rulemaking 81 FR 31680 (May 19, 2016) The proposed standards are equivalent to 10 – 15 % losses reduction relative to a regression curve (market average)
Current Standard	None
Test Procedure	None – Proposed Test Procedure is based on ISO 1217:2009 with modifications 81 FR 27220 (May 5, 2016)

  - The standard levels were proposed using a "d-value" representing a percent losses reduction relative to a regression curve (similar to the EU methodology)

Note: DOE published a pre-publication final rule on December 5, 2016

http://energy.gov/eere/buildings/downloads/issuance-2016-12-05-energy-conservation-program-energy-conservation

- **Metric Approach**
  - Isentropic efficiency
  - Evaluated at full-load or over a load profile (variable-speed)

Next Steps

- DOE is required to review existing standards for covered products at least once every six years and to set standards at levels that achieve the maximum improvement in energy efficiency that is "technically feasible and economically justified" (42 U.S.C. 6295(m)(1) and 6316(a))

- Similarly, DOE is required to review existing test procedures at least every 7 years. (42 U.S.C. 6314(a))

- DOE will begin the process of reviewing standards and test procedures for Small Electric Motors

For more information, visit:

http://energy.gov/eere/buildings/appliance-and-equipment-standards-program