Appliance Standards guidance documents are accessible on the U.S. Department of Energy, Energy Efficiency & Renewable Energy web site at:
http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1.

Guidance Type: Enforcement
Category: Commercial Equipment
Product: Small, Large, and Very Large, Air-Cooled, Water-Cooled, and Evaporatively-Cooled Commercial Package Air Conditioners and Heat Pumps, Water-Source Heat Pumps, Single Package Vertical Units, and Computer Room Air Conditioners
Product Sub-type: All
Guidance Version: DRAFT
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The following is a draft U.S. Department of Energy (DOE or the Department) document regarding how to evaluate whether small, large, and very large air-cooled, water-cooled, and evaporatively-cooled commercial package air conditioners and heat pumps, water-source heat pumps, single package vertical units, and computer room air conditioners offered for sale with a variety of high static indoor blower or oversized motor to qualify for a related DOE enforcement policy.

This draft document is seeking comment regarding the best way to effectuate an enforcement policy and is not an interpretation of DOE's regulations.

Comments and suggestions should be provided in WordPerfect, Microsoft Word, PDF, or text file format by sending an email to ComHVACMotorGuidance@ee.doe.gov. Please also include the docket number EERE-2015-BT-GUID-0011. At the end of the comment period, this draft document may be adopted or revised.

During a negotiated rulemaking regarding Certification for Commercial Heating, Ventilation, Air-Conditioning, Water-Heating, and Refrigeration Equipment, DOE agreed to adopt an enforcement policy under which DOE would not test a model of HVAC equipment with a high-static indoor blower or over-sized motor provided (1) the manufacturer offers an otherwise equivalent model that contains a "standard motor" *and* (2) the high static indoor blower/oversized motor has the same (or better) relative efficiency performance as the "standard motor". Due to time constraints in the negotiation, the parties did not define how to compare the efficiencies of motors for the purposes of this policy, but the parties did talk through and agree to the concept broadly. Instead, the parties agreed DOE would issue guidance to resolve that issue after accepting additional comment on the details of the procedure.

DOE proposes the following approach to compare the efficiencies of a "standard motor" and a high-static indoor blower/oversized motor ("oversized motor"):

Standard Motor	Oversized Motor	OK to substitute oversized motor? (DOE would not test a unit with the oversized motor.)
Subject to standards Can be tested with DOE TP	Subject to standards Can be tested with DOE TP	Yes, if relative efficiency of oversized motor is at least as good as performance of standard motor
Subject to standards	Not subject to standards	Yes, if relative efficiency of oversized motor is at

Can be tested with DOE TP	Can be tested with DOE TP	least as good as performance of standard motor
Not subject to standards Can be tested with DOE TP	Subject to standards Can be tested with DOE TP	Yes, if relative efficiency of oversized motor is at least as good as performance of standard motor
Not subject to standards Can be tested with DOE TP	Not subject to standards Can be tested with DOE TP	Yes, if relative efficiency of oversized motor is at least as good as performance of standard motor
Subject to standards Can be tested with DOE TP	Not subject to standards Cannot be tested with DOE TP but can be tested with industry method	Cannot substitute oversized motor
Not subject to standards Can be tested with DOE TP	Not subject to standards Cannot be tested with DOE TP but can be tested with industry method	Cannot substitute oversized motor
Not subject to standards Cannot be tested with DOE TP but can be tested with industry method	Not subject to standards Cannot be tested with DOE TP but can be tested with industry method	Yes, if relative efficiency of oversized motor is at least as good as performance of standard motor – and both motors are tested using same industry method
No standard test method	No standard test method	Cannot substitute oversized motor
Motors with horsepower < 1	Motors with horsepower < 1	Cannot substitute oversized motor
Motors with horsepower < 1	Motors with horsepower ≥ 1	Cannot substitute oversized motor

Determining relative efficiency of the motor

Compare the percent losses of the standard motor to the percent losses of the oversized motor. The percent losses in a standard or oversized motor are determined by comparing each motor's wattage losses to the wattage losses of a corresponding reference motor. Although DOE appreciates that a variety of motor sizes, construction, and purposes are used in HVAC equipment, the HVAC members of the Commercial Certification Working Group stated that it was unfamiliar with the standards tables for electric motors and recommended that DOE should adopt a relatively simple way for DOE to implement its enforcement policy with respect to motor substitution. Accordingly, DOE does not believe that the reference motors need to reflect such a level of granularity because the motors generally scale in a similar manner.

The Federal standard levels for 4 pole, open frame, general purpose electric motors (subtype I) (*see* 10 CFR 431.25(a)) would be used to scale the performance of the standard motor to an oversized motor whether the motors are subject to Federal standard levels or not. Use the following steps to determine if an oversized motor is a suitable substitute for the standard motor for the purposes of DOE's enforcement policy.[1]

[1] Note, that 10 CFR 429.71 requires manufacturers to retain documentation supporting its certifications of compliance. Accordingly, any manufacturer using this methodology is required to maintain documentation of how the standard and oversized motor's losses were determined and the supporting calculations specified below to demonstrate that it had ensured the substituted motor is authorized under the enforcement policy.

1. Using the tested efficiency of the standard motor, determine the wattage losses of the standard motor ($Loss_{std}$) with the following equation, where η_{std} is the tested efficiency of the standard motor and hp_{std} is the horsepower of the standard motor:

$$Loss_{std} = 746 * hp_{std} * \frac{1-\eta_{std}}{\eta_{std}}$$

2. Determine the appropriate reference motor efficiency corresponding to the standard motor (standard motor reference efficiency, η_{rs}). Using the Federal standard levels for 4 pole, open frame, general purpose electric motors (subtype I) in 10 CFR 431.25(a), look up the efficiency level that corresponds to the standard motor's horsepower.

3. Using the standard reference motor efficiency, determine the percent losses of the standard reference motor ($Loss_{rs}$) with the following equation, where η_{rs} is the standard reference motor efficiency and hp_{rs} is the horsepower of the standard reference motor (hp_{rs} is equivalent to the horsepower of the standard motor):

$$Loss_{rs} = 746 * hp_{rs} * \frac{1-\eta_{rs}}{\eta_{rs}}$$

4. With the wattage losses for both the standard motor and the standard reference motor, calculate the percentage losses of the standard motor as follows:

$$\%Loss = 100 * \frac{(Loss_{rs}-Loss_{std})}{Loss_{rs}}$$

5. Determine the appropriate reference motor efficiency corresponding to the oversized motor (oversized motor reference efficiency, η_{ro}). Using the Federal standard levels for 4 pole, open frame, general purpose electric motors (subtype I) in 10 CFR 431.25(a), look up the efficiency level that corresponds to the oversized motor's horsepower.

6. Using the oversized reference motor efficiency, determine the percent losses of the oversized reference motor ($Loss_{ro}$) with the following equation, where η_{ro} is the oversized reference motor efficiency and hp_{ro} is the horsepower of the oversized reference motor (hp_{ro} is equivalent to the horsepower of the oversized motor):

$$Loss_{ro} = 746 * hp_{ro} * \frac{1-\eta_{ro}}{\eta_{ro}}$$

7. With the wattage losses for the oversized reference motor ($Loss_{ro}$) and the percent losses of the standard motor (%Loss), determine the allowable losses in watts for the oversized motor.

$$Allowable\ Losses = (1 - \%Loss) * Loss_{ro}$$

8. From the allowable losses, the minimum efficiency for the oversized motor (η_o) can be calculated according to the following equation, where hp_o is the horsepower for the oversized motor.

$$\eta_o = 100 * \frac{(hp_o*746)}{(hp_o*746+Allowable\ Losses)}$$

9. The oversized motor is an acceptable substitute for the standard motor if the tested efficiency of the oversized motor is greater than or equal to η_o.

Example: A basic model commercial air conditioner was rated with a 5hp motor that has an efficiency of 91.7%. If a manufacturer wants to sell this basic model commercial air conditioner with a 10hp motor as well, what is the minimum efficiency required for the 10hp motor?

The standard motor for this basic model of commercial air conditioner is the 5hp with an efficiency of 91.7%. The wattage losses of the standard motor are:

$$Loss_{std} = 746 * hp_{std} * \frac{1-\eta_{std}}{\eta_{std}} = 746 * 5hp * \frac{1-0.917}{0.917} = 337.6W$$

The reference motor efficiency corresponding to the standard motor is determined by looking up the appropriate value based on the standard motor's horsepower in the Federal standard levels for 4 pole, open frame, general purpose electric motors (subtype I) in 10 CFR 431.25(a) . The reference efficiency for 5hp motor is 89.5%. 10 CFR 431.25(a). The standard reference efficiency is used to calculate the wattage losses for the standard reference motor.

$$Loss_{rs} = 746 * hp_{rs} * \frac{1-\eta_{rs}}{\eta_{rs}} = 746 * 5hp * \frac{1-0.895}{0.895} = 437.6W$$

Using the wattage losses for the standard motor and standard reference motor, calculate the percent losses.

$$\%Loss = 100 * \frac{(Loss_{rs} - Loss_{std})}{Loss_{rs}} = 100 * \frac{(437.6 - 337.6)}{437.6} = 22.8\%$$

Therefore, if a manufacturer wants to use a 10hp oversized motor in this commercial air conditioner basic model then the oversized motor must have at least 22.8% fewer losses than the corresponding oversized reference motor.

The efficiency of the oversized reference motor can be found by looking up the efficiency for a 10hp in the Federal standard levels for 4 pole, open frame, general purpose electric motors (subtype I) in 10 CFR 431.25(a). The oversized reference motor efficiency for the 10hp motor is 91.7%. (10 CFR 431.25(a)) Calculate the oversized reference motor's wattage losses from the efficiency of the oversized reference motor:

$$Loss_{ro} = 746 * hp_{ro} * \frac{1-\eta_{ro}}{\eta_{ro}} = 746 * 10hp * \frac{1-0.917}{0.917} = 675.2W$$

Then determine the allowable losses in watts for the oversized motor.

$$Allowable\ Losses = (1 - \%Loss) * Loss_{ro} = (1 - 0.228) * 675.2W = 521.3\ W$$

Finally, determine the acceptable minimum efficiency for the oversized motor.

$$\eta_o = 100 * \frac{(hp_o * 746)}{(hp_o * 746 + Allowable\ Losses)} = 100 * \frac{(10hp * 746)}{(10hp * 746 + 521.3W)} = 93.5\%$$

In summary, a 10hp motor with a minimum efficiency of 93.5% is an acceptable substitute for a 5hp standard motor with 91.7% efficiency according to DOE's propose enforcement policy.

$$Acceptable\ 10hp\ motor\ efficiency\ \geq \eta_o$$

93.5% > 91.7% ∴ substitution permitted