(3) *Polyphase small electric motors of less than or equal to 1 horsepower (0.75 kW).* For polyphase small electric motors with 1 horsepower or less, use one of the following methods:

(i) IEEE 112–2017 Test Method A, Section 3, ''General'', Section 4, ''Measurements'', Section 5, ''Machine losses and tests for losses'', Section 6.1, ''General'', Section 6.3, ''Efficiency test method A—Input-output'', Section 9.2, ''Form A—Method A'', and Section 9.3, ''Form A2—Method A calculations'';

(ii) CSA C747–09, Section 1.6 ''Scope'', Section 3 ''Definitions'', Section 5, ''General test requirements'', and Section 6 ''Test method'';

(iii) IEC 60034–2–1:2014 Method 2–1–1A, Section 3 ''Terms and definitions'', Section 4 ''Symbols and abbreviations'', Section 5 ''Basic requirements'', and Section 6.1.2 ''Method 2–1–1A—Direct measurement of input and output'' (except Section 6.1.2.2, ''Test Procedure''). The supply voltage shall be in accordance with section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 therein, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with section 5.2 of IEC 60051–1:2016.

(A) *Additional IEC 60034–2–1:2014 Method 2–1–1A Torque Measurement Instructions.*

If using IEC 60034–2–1:2014 Method 2–1–1A to measure motor performance, follow the instructions in paragraph (b)(3)(iii)(B) of this section, instead of section 6.1.2.2 of IEC 60034–2–1:2014;

(B) Couple the machine under test to load machine. Measure torque using an in-line shaft-coupled, rotating torque transducer or stationary, stator reaction torque transducer. Operate the machine under test at the rated load until thermal equilibrium is achieved (rate of change 1 K or less per half hour). Record U, I, Pel, n, T, θc.

(4) *Polyphase small electric motors of greater than 1 horsepower (0.75 kW).* For polyphase small electric motors exceeding 1 horsepower, use one of the following methods:

(i) IEEE 112–2017 Test Method B, Section 3, ''General''; Section 4, ''Measurements''; Section 5, ''Machine losses and tests for losses'', Section 6.1, ''General'', Section 6.4, ''Efficiency test method B—Input-output with loss segregation'', Section 9.4, ''Form B—Method B'', and Section 9.5, ''Form B2—Method B calculations''; or

(ii) CSA C390–10, Section 1.3, ''Scope'', Section 3.1, ''Definitions'', Section 5, ''General test requirements—Measurements'', Section 7, ''Test method'', Table 1, ''Resistance measurement time delay, Annex B, ''Linear regression analysis'', and Annex C, ''Procedure for correction of dynamometer torque readings''; or

(iii) IEC 60034–2–1:2014 Method 2–1–1B Section 3 ''Terms and definitions'', Section 4 ''Symbols and abbreviations'', Section 5 ''Basic requirements'', Section 6.1.3 ''Method 2–1–1B—Summation of losses, additional load losses according to the method of residual losses.'', and Annex D, ''Test report template for 2–1–1B. The supply voltage shall be in accordance with section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 therein, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with section 5.2 of IEC 60051–1:2016.

[86 FR 23, Jan. 4, 2021]

§ 431.445 Determination of small electric motor efficiency.

(a) *Scope.* When a party determines the energy efficiency of a small electric motor to comply with an obligation imposed on it by or pursuant to Part A–1 of Title III of EPCA, 42 U.S.C. 6311–6317, this section applies.

(b) *Provisions applicable to all small electric motors*—(1) *General requirements.* The average full-load efficiency of each basic model of small electric motor

must be determined either by testing in accordance with § 431.444 of this subpart, or by application of an alternative efficiency determination method (AEDM) that meets the requirements of paragraphs (a)(2) and (3) of this section, provided, however, that an AEDM may be used to determine the average full-load efficiency of one or more of a manufacturer's basic models only if the average full-load efficiency of at least five of its other basic models is determined through testing.

(2) *Alternative efficiency determination method.* An AEDM applied to a basic model must be:

(i) Derived from a mathematical model that represents the mechanical and electrical characteristics of that basic model, and

(ii) Based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data.

(3) *Substantiation of an alternative efficiency determination method.* Before an AEDM is used, its accuracy and reliability must be substantiated as follows:

(i) The AEDM must be applied to at least five basic models that have been tested in accordance with § 431.444; and

(ii) The predicted total power loss for each such basic model, calculated by applying the AEDM, must be within plus or minus 10 percent of the mean total power loss determined from the testing of that basic model.

(4) *Subsequent verification of an AEDM.* (i) Each manufacturer that has used an AEDM under this section shall have available for inspection by the Department of Energy records showing the method or methods used; the mathematical model, the engineering or statistical analysis, computer simulation or modeling, and other analytic evaluation of performance data on which the AEDM is based; complete test data, product information, and related information that the manufacturer has generated or acquired pursuant to paragraph (a)(3) of this section; and the calculations used to determine the efficiency and total power losses of each basic model to which the AEDM was applied.

(ii) If requested by the Department, the manufacturer shall conduct simulations to predict the performance of particular basic models of small electric motors specified by the Department, analyses of previous simulations conducted by the manufacturer, sample testing of basic models selected by the Department, or a combination of the foregoing.

(5) *Use of a certification program.* (i) A manufacturer may use a certification program, that DOE has classified as nationally recognized under § 431.447, to certify the average full-load efficiency of a basic model of small electric motor, and issue a certificate of conformity for the small electric motor.

(ii) For each basic model for which a certification program is not used as described in paragraph (b)(5)(i) of this section, any testing of a motor to determine its energy efficiency must be carried out in accordance with paragraph (c) of this section.

(c) *Additional testing requirements applicable when a certification program is not used*—(1) *Selection of basic models for testing.* (i) Basic models must be selected for testing in accordance with the following criteria:

(A) Two of the basic models must be among the five basic models that have the highest unit volumes of production by the manufacturer in the prior year, or during the prior 12 calendar month period beginning in 2015, whichever is later, and comply with the standards set forth in § 431.446;

(B) The basic models should be of different horsepowers without duplication;

(C) At least one basic model should be selected from each of the frame number series for which the manufacturer is seeking compliance; and

(D) Each basic model should have the lowest average full-load efficiency among the basic models with the same rating (''rating'' as used here has the same meaning as it has in the definition of ''basic model'').

(ii) In any instance where it is impossible for a manufacturer to select basic models for testing in accordance with all of these criteria, the criteria shall be given priority in the order in which they are listed. Within the limits imposed by the criteria, basic models shall be selected randomly.

(2) *Selection of units for testing within a basic model.* For each basic model selected for testing,[1] a sample of units shall be selected at random and tested. The sample shall be comprised of production units of the basic model, or units that are representative of such production units. The sample size shall be no fewer than five units, except when fewer than five units of a basic model would be produced over a reasonable period of time (approximately 180 days). In such cases, each unit produced shall be tested.

(3) *Applying results of testing.* When applying the test results to determine whether a motor complies with the required average efficiency level:

The average full-load efficiency of the sample, $\bar{X}$ which is defined by

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

where X_i is the measured full-load efficiency of unit i and n is the number of units tested, shall satisfy the condition:

$$\overline{X} \geq \frac{100}{1 + 1.05\left(\frac{100}{RE} - 1\right)}$$

where RE is the required average full-load efficiency.

[74 FR 32072, July 7, 2009, as amended at 77 FR 26638, May 4, 2012]

ENERGY CONSERVATION STANDARDS

§ 431.446 Small electric motors energy conservation standards and their effective dates.

(a) Each small electric motor manufactured (alone or as a component of another piece of non-covered equipment) after March 9, 2015, or in the case of a small electric motor which requires listing or certification by a nationally recognized safety testing laboratory, after March 9, 2017, shall have an average full load efficiency of not less than the following:

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Polyphase		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	67.5	69.5	65.6
0.33/0.25	71.4	73.4	69.5
0.5/0.37	75.3	78.2	73.4
0.75/0.55	81.7	81.1	76.8
1/0.75	82.5	83.5	77.0
1.5/1.1	83.8	86.5	84.0
2/1.5	N/A	86.5	85.5
3/2.2	N/A	86.9	85.5

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Capacitor-start capacitor-run and capacitor-start induction-run		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	62.2	68.5	66.6
0.33/0.25	66.6	72.4	70.5
0.5/0.37	76.2	76.2	72.4
0.75/0.55	80.2	81.8	76.2
1/0.75	81.1	82.6	80.4
1.5/1.1	N/A	83.8	81.5
2/1.5	N/A	84.5	82.9
3/2.2	N/A	N/A	84.1

(b) For purposes of determining the required minimum average full load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of efficiency standards in paragraph (a) of this section, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepower ratings shall be rounded up to the higher of the two horsepower ratings;

(2) A horsepower below the midpoint between the two consecutive horsepower ratings shall be rounded down to the lower of the two horsepower ratings; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = (1/0.746) hp, without calculating beyond three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraphs (b)(1) or (b)(2) of this section, whichever applies.

[75 FR 10947, Mar. 9, 2010; 75 FR 17036, Apr. 5, 2010]

[1] Components of similar design may be substituted without requiring additional testing if the represented measures of energy consumption continue to satisfy the applicable sampling provision.