DOCKETED	
Docket Number:	18-AAER-05
Project Title:	Commercial and Industrial Air Compressors
TN #:	228740
Document Title:	OAL Notice of approval of Regulatory Action
Description:	OAL approval final form 400 final text for commercial and industrial air compressors
Filer:	Alex Galdamez
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	6/12/2019 8:58:41 AM
Docketed Date:	6/12/2019

State of California
Office of Administrative Law

In re:
California Energy Commission

Regulatory Action:

Title 20, California Code of Regulations

Adopt sections:
Amend sections: 1601, 1602, 1604, 1605.1, 1605.2, 1605.3, 1606, 1608
Repeal sections:

NOTICE OF APPROVAL OF REGULATORY ACTION

Government Code Section 11349.3

OAL Matter Number: 2019-0426-01

OAL Matter Type: Regular (S)

This action adopts definitions, test procedures, reporting requirements, and efficiency standards for air compressors.

OAL approves this regulatory action pursuant to section 11349.3 of the Government Code. This regulatory action becomes effective on 6/10/2019.

Date: June 10, 2019

Mark Storm
Senior Attorney

For: Holly Pearson
Acting Director

Original: Drew Bohan, Executive Director
Copy: Corrine Fishman

STATE OF CALIFORNIA--OFFICE OF ADMINISTRATIVE LAW

NOTICE PUBLICATION/REGULATIONS SUBMISSION

REGULAR

(See instructions on reverse)

For use by Secretary of State only

STD. 400 (REV. 01-2013)

OAL FILE NUMBERS	NOTICE FILE NUMBER	REGULATORY ACTION NUMBER	EMERGENCY NUMBER
	Z-2018-1106-01	2019-0426-01S	

For use by Office of Administrative Law (OAL) only

2019 APR 26 A 10:28

OFFICE OF ADMINISTRATIVE LAW

NOTICE | REGULATIONS

ENDORSED - FILED
In the office of the Secretary of State
of the State of California
JUN 10 2019
4:11 PM

AGENCY WITH RULEMAKING AUTHORITY
The California Energy Commission

AGENCY FILE NUMBER (If any)
18-AAER-05

A. PUBLICATION OF NOTICE (Complete for publication in Notice Register)

1. SUBJECT OF NOTICE	TITLE(S)	FIRST SECTION AFFECTED	2. REQUESTED PUBLICATION DATE
Appliance Efficiency Regulations	20	1601	November 16, 2018

3. NOTICE TYPE	4. AGENCY CONTACT PERSON	TELEPHONE NUMBER	FAX NUMBER (Optional)
[X] Notice re Proposed Regulatory Action [ ] Other	Corrine Fishman	916-654-4976	

OAL USE ONLY	ACTION ON PROPOSED NOTICE	NOTICE REGISTER NUMBER	PUBLICATION DATE
	[ ] Approved as Submitted [ ] Approved as Modified [ ] Disapproved/ Withdrawn	2018 46-Z	11/16/2018

B. SUBMISSION OF REGULATIONS (Complete when submitting regulations)

1a. SUBJECT OF REGULATION(S)	1b. ALL PREVIOUS RELATED OAL REGULATORY ACTION NUMBER(S)
Appliance Efficiency Regulations	

2. SPECIFY CALIFORNIA CODE OF REGULATIONS TITLE(S) AND SECTION(S) **(Including title 26, if toxics related)**

SECTION(S) AFFECTED (List all section number(s) individually. Attach additional sheet if needed.)	
	ADOPT
	AMEND: 1601, 1602, 1604, 1605.1, 1605.2, 1605.3, 1606, 1608,
TITLE(S): 20	REPEAL

3. TYPE OF FILING

- [X] Regular Rulemaking (Gov. Code §11346)
- [ ] Resubmittal of disapproved or withdrawn nonemergency filing (Gov. Code §§11349.3, 11349.4)
- [ ] Emergency (Gov. Code, §11346.1(b))
- [ ] Certificate of Compliance: The agency officer named below certifies that this agency complied with the provisions of Gov. Code §§11346.2-11347.3 either before the emergency regulation was adopted or within the time period required by statute.
- [ ] Resubmittal of disapproved or withdrawn emergency filing (Gov. Code, §11346.1)
- [ ] Emergency Readopt (Gov. Code, §11346.1(h))
- [ ] File & Print
- [ ] Other (Specify) _____
- [ ] Changes Without Regulatory Effect (Cal. Code Regs., title 1, §100)
- [ ] Print Only

4. ALL BEGINNING AND ENDING DATES OF AVAILABILITY OF MODIFIED REGULATIONS AND/OR MATERIAL ADDED TO THE RULEMAKING FILE (Cal. Code Regs. title 1, §44 and Gov. Code §11347.1)

5. EFFECTIVE DATE OF CHANGES (Gov. Code, §§ 11343.4, 11346.1(d); Cal. Code Regs., title 1, §100)

- [ ] Effective January 1, April 1, July 1, or October 1 (Gov. Code §11343.4(a))
- [X] Effective on filing with Secretary of State
- [ ] §100 Changes Without Regulatory Effect
- [ ] Effective other (Specify) _____

6. CHECK IF THESE REGULATIONS REQUIRE NOTICE TO, OR REVIEW, CONSULTATION, APPROVAL OR CONCURRENCE BY, ANOTHER AGENCY OR ENTITY

- [ ] Department of Finance (Form STD. 399) (SAM §6660)
- [ ] Fair Political Practices Commission
- [ ] State Fire Marshal
- [ ] Other (Specify) _____

7. CONTACT PERSON	TELEPHONE NUMBER	FAX NUMBER (Optional)	E-MAIL ADDRESS (Optional)
Corrine Fishman	916-654-4976		

8. **I certify that the attached copy of the regulation(s) is a true and correct copy of the regulation(s) identified on this form, that the information specified on this form is true and correct, and that I am the head of the agency taking this action, or a designee of the head of the agency, and am authorized to make this certification.**

SIGNATURE OF AGENCY HEAD OR DESIGNEE

DATE: 4/25/19

TYPED NAME AND TITLE OF SIGNATORY
Drew Bohan, Executive Director

For use by Office of Administrative Law (OAL) only

ENDORSED APPROVED

JUN 10 2019

Office of Administrative Law

Proposed Regulatory Language

California Code of Regulations
Title 20. Public Utilities and Energy
Division 2. State Energy Resources Conservation and Development Commission
Chapter 4. Energy Conservation
Article 4. Appliance Efficiency Regulations
Sections 1601 - 1609
As related to commercial and industrial air compressors

November 16, 2018

The proposed new language appears as underline (example) and proposed deletions appear as strikeout (~~example~~). Existing language appears as plain text. Three dots or "..." represents the substance of the regulations that exists between the proposed language and current language.

Language shown in italics (*example*) is language proposed by the Energy Commission related to portable air conditioners, docket number 18-AAER-04, and published with OAL on October 12, 2018, file number Z-2018-1002-03.

Section 1601. Scope.

This Article applies to the following types of new appliances, if they are sold or offered for sale in California, except those sold wholesale in California for final retail sale outside the state and those designed and sold exclusively for use in recreational vehicles, or other mobile equipment. Unless otherwise specified, each provision applies only to units manufactured on or after the effective date of the provision.

> NOTE: For the applicability of these regulations to appliances installed in new building construction, see sections 110.0 and 110.1 of part 6 of Title 24 of the California Code of Regulations.

...[skipping (a) through (r)]

(s) Electric motors and compressors, which are:

(1) electric motors, excluding definite purpose motors, special purpose motors, and motors exempted by the U.S. Department of Energy under 42 U.S.C. *s*ection 6313(b); or

(2) state-regulated compressors~~,~~ as defined in Section 1602 of this Article. ~~which are federally regulated commercial and industrial air compressors.~~

...[skipping (t) through end of Section 1601]

Note Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c), 25402.5.4, and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1602. Definitions.

(a) General

...[skipping "In this Article..." through "Color rendering index (CRI)"]

"Commercial and industrial equipment" means an article of equipment, regardless of whether it is in fact distributed in commerce for industrial or commercial use, of a type which:

(1) In operation consumes, or is designed to consume energy;

(2) To any significant extent, is distributed in commerce for industrial or commercial use; and

(3) Is not a consumer product, as defined in section 1602(a).

...[skipping "Compact Fluorescent lamp (CFL)" through (r)]

(s) Electric Motors and Compressors.

...[skipping "Accreditation" through "Air compressor"]

"Air-cooled compressor" means a compressor that utilizes air to cool both the compressed air and, if present, any auxiliary substance used to facilitate compression, and that is not a liquid-cooled compressor.

...[skipping "Air-over electric motor" through "Alternative efficiency determination method"]

"Alternative efficiency determination method" or AEDM, means, with respect to a state-regulated compressor, a method of calculating the package isentropic efficiency, package specific power, pressure ratio at full-load operating pressure, full-load actual volume flow rate, or full-load operating pressure.

"Ancillary equipment" means any equipment ~~distributed in commerce~~ sold or offered for sale in California with an air compressor but that is not a bare compressor, driver, or mechanical equipment. Ancillary equipment is considered to be part of a given air compressor, regardless of whether the ancillary equipment is physically attached to the bare compressor, driver, or

mechanical equipment at the time when the air compressor is ~~distributed in commerce~~ sold or offered for sale in California.

...[skipping "Auxiliary substance" through "Bare compressor"]

~~"Basic model" of a federally regulated compressor means all units of a class of compressors manufactured by one manufacturer, having the same primary energy source, the same compressor motor nominal horsepower, and essentially identical electrical, physical, and functional (or pneumatic) characteristics that affect energy consumption and energy efficiency.~~

...[skipping "Basic model" of a federally regulated electric motor" through "Basic model" of a federally regulated small electric motor"]

"Basic model" of a state-regulated compressor means all units of a class of compressors manufactured by one manufacturer, having the same primary energy source, the same compressor motor nominal horsepower, and essentially identical electrical, physical, and functional (or pneumatic) characteristics that affect energy consumption and energy efficiency.

"Brushless electric motor" means a machine that converts electrical power into rotational mechanical power without use of sliding electrical contacts.

...[skipping "Certification program" through "Compressor" means a machine]

"Compressor motor nominal horsepower" means the motor horsepower of the electric motor, as determined in accordance with the applicable procedures in 10 C.F.R. part 431 subparts B and X, with which the rated air compressor is ~~distributed in commerce~~ sold or offered for sale in California.

...[skipping "Definite purpose electric motor" through "Fire pump electric motor"]

"Fixed-speed compressor" means an air compressor that is not capable of adjusting the speed of the driver continuously over the driver operating speed range in response to incremental changes in the required compressor flow rate.

...[skipping "Full-load actual volume flow rate" through "IEC Design N motor"]

"Liquid-cooled compressor" means a compressor that utilizes liquid coolant provided by an external system to cool both the compressed air and, if present, any auxiliary substance used to facilitate compression.

"Liquid-ring compressor" means a compressor that has an impeller with blades that are located in a cylindrical housing and arranged eccentrically relative to the housing, where the liquid acts

as a liquid ring arranged concentrically to the housing and eccentrically to the impeller, forming the compression chamber.

"Lubricated compressor" means a compressor that introduces an auxiliary substance into the compression chamber during compression.

"Maximum full-flow operating pressure" means the maximum discharge pressure at which the compressor is capable of operating, as determined in accordance with the test procedure prescribed in section 1604(s) of this Article.

...[skipping "Mechanical equipment" through "Package isentropic efficiency"]

"Package specific power" means the compressor power input at a given load point, divided by the actual volume flow rate at the same load point, as determined in accordance with the test procedure prescribed in section 1604(s) of this Article.

"Positive displacement compressor" means a compressor in which the admission and diminution of successive volumes of the gaseous medium are performed periodically by forced expansion and diminution of a closed space(s) in a working chamber(s) by means of displacement of a moving member(s) or by displacement and forced discharge of the gaseous medium into the high-pressure area.

"Pressure ratio at full-load operating pressure" means the ratio of discharge pressure to inlet pressure, determined at full-load operating pressure in accordance with the test procedures prescribed in ~~*10 C.F. R. section 431.344*~~section 1604(s) of this Article.

"Reciprocating compressor" means a positive displacement compressor in which gas admission and diminution of its successive volumes or its forced discharge are performed cyclically by straight-line alternating movements of a moving member(s) in a compression chamber(s).

...[skipping "Rotor"]

"Rotary compressor" means a positive displacement compressor in which gas admission and diminution of its successive volumes or its forced discharge are performed cyclically by rotation of one or several rotors in a compressor casing.

...[skipping "Small electric motor" through "Special purpose motor"]

"State-regulated compressor" means commercial and industrial equipment that meets all of the following criteria:

(1) is an air compressor,
(2) is a rotary compressor,

(3) is not a liquid-ring compressor,
(4) is driven by a brushless electric motor,
(5) is a lubricated compressor,
(6) has a full-load operating pressure greater than or equal to 75 pounds per square inch gauge (psig) and less than or equal to 200 psig,
(7) is not designed and tested to the requirements of The American Petroleum Institute standard 619, "Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries,"
(8) has full-load actual volume flow rate greater than or equal to 35 cubic feet per minute (cfm), or is sold or offered for sale with a compressor motor nominal horsepower greater than or equal to 10 horsepower (hp),
(9) has a full-load actual volume flow rate less than or equal to 1,250 cfm, or is sold or offered for sale with a compressor motor nominal horsepower less than or equal to 200 hp,
(10) is driven by a three-phase electric motor,
(11) is manufactured alone or as a component of another piece of equipment; and
(12) is one of the equipment classes listed in Table S-5.

...[skipping "Total power loss" through end of section 1602]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c), 25402.5.4, and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1602.1 Rules of Construction - No change

Section 1603. Testing: All Appliances - No change

Section 1604. Test Methods for Specific Appliances.

...[skipping (a) through (r)]

(s) Electric Motors and Compressors.

...[skipping (1) and (2)]

(3) Compressors. The test method for state-regulated compressors is 10 C.F.R. section 431.344 (Appendix A to Subpart T of 10 C.F.R., § 431), including but not limited to provisions on alternative efficiency determination method (AEDM) and additional testing requirements

concerning selection of models to be tested if an AEDM is to be applied, in 10 C.F.R. section 429.63 and 10 C.F.R. section 429.70.

...[skipping (t) through (w)]

The following documents are incorporated by reference in section 1604.

...[skipping California Energy Commission Test Methods]

FEDERAL TEST METHODS

C.F.R., Title 10, section 429.56, 429.63, and 429.70
C.F.R., Title 10, section 430.23, and 10 C.F.R. Appendixes A, B, C1, D1, D2, E, F, H, I, J1, J2, M, N, O, P, Q, R, S, T, U, V, W, X, S1, Y, Z, AA, BB, and CC of subpart B of part 430
C.F.R., Title 10, sections 431.15, 431.16, 431.17, 431.18, 431.19, 431.20, and 431.21
C.F.R., Title 10, sections 431.63 and 431.64
C.F.R., Title 10, sections 431.75 and 431.76
C.F.R., Title 10, sections 431.85 and 431.86
C.F.R., Title 10, sections 431.95 and 431.96
C.F.R., Title 10, sections 431.105 and 431.106
C.F.R., Title 10, sections 431.133 and 431.134
C.F.R., Title 10, section 431.193
C.F.R., Title 10, section 431.204(b)
C.F.R., Title 10, section 431.224
C.F.R., Title 10, sections 431.263 and 431.264
C.F.R., Title 10, sections 431.293 and 431.294
C.F.R., Title 10, sections 431.303 and 431.304
C.F.R., Title 10, sections 431.344, Appendix A to Subpart T of 10 C.F.R., § 431
C.F.R., Title 10, sections 431.443, 431.444, and 431.445
C.F.R., Title 10, section 431.464
C.F.R., Title 10, section 431 subpart G

Copies available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
www.ecfr.gov

...[skipping United States Environmental Protection Agency (EPA) through end of section 1604]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Reference: Sections 25216.5(d), 25402(a)-25402(c) and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1605. Energy Performance, Energy Design, Water Performance, and Water Design Standards: In General - No change

Section 1605.1. Federal and State Standards for Federally Regulated Appliances.

...[skipping (a) through (r)]

(s) Electric Motors and Compressors.

...[skipping (1) through 6)]

(7) **Compressors.** ~~There are no standards for federally regulated compressors.~~ See section 1605.3(s) of this Article for energy efficiency standards for state-regulated compressors.

...[skipping (t) through end of section 1605.1]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c), and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1605.2 State Standards for Federally Regulated Appliances.

...[skipping (a) through (r)]

(s) Electric Motors and Compressors.

...[skipping (1)]

(2) **Compressors.** ~~There are no energy efficiency standards for federally regulated compressors.~~ See section 1605.3(s) of this Article for energy efficiency standards for state-regulated compressors.

...[skipping (t) through end of section 1605.2]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c), and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1605.3 State Standards for Non-Federally-Regulated Appliances.

...[skipping (a) through (r)]

(s) Electric Motors and Compressors.

...[skipping (1)]

(2) **Compressors.** ~~There are no energy efficiency standards for federally regulated compressors.~~ State-regulated compressors manufactured on or after January 1, 2022, shall meet the applicable performance values in Table S-5.

Table S-5
Standards for State-regulated Compressors

Equipment Class	Minimum Package Isentropic Efficiency†	η_{Regr} (package isentropic efficiency reference curve)	d (Percentage Loss Reduction)
Rotary, lubricated, air-cooled, fixed-speed compressor	$\eta_{Regr} + (1 - \eta_{Regr}) * \left(\frac{d}{100}\right)$	$-0.00928 * ln^2(.4719 * V_1) + 0.13911 * \ln(.4719 * V_1) + 0.27110$	-15
Rotary, lubricated, air-cooled, variable-speed compressor	$\eta_{Regr} + (1 - \eta_{Regr}) * \left(\frac{d}{100}\right)$	$-0.01549 * ln^2(.4719 * V_1) + 0.21573 * ln(.4719 * V_1) + 0.00905$	-10
Rotary, lubricated, liquid-cooled, fixed-speed compressor	$.02349 + \eta_{Regr} + (1 - \eta_{Regr}) * \left(\frac{d}{100}\right)$	$-0.00928 * ln^2(.4719 * V_1) + 0.13911 * ln(.4719 * V_1) + 0.27110$	-15
Rotary, lubricated, liquid-cooled, variable-speed compressor	$.02349 + \eta_{Regr} + (1 - \eta_{Regr}) * \left(\frac{d}{100}\right)$	$-0.01549 * ln^2(.4719 * V_1) + 0.21573 * ln(.4719 * V_1) + 0.00905$	-15

Where V_1 is the full-load actual volume flow rate of the compressor, in cubic feet per minute, as determined in accordance with the test procedure in section 1604(s).

† For "fixed-speed compressor" equipment classes, the relevant Package Isentropic Efficiency is Full-load Package Isentropic Efficiency. For "Variable-speed compressor" equipment classes, the relevant Package Isentropic Efficiency is Part-load Package Isentropic Efficiency. Both Full- and Part-Load Package Isentropic Efficiency are determined in accordance with the test procedure in section 1604(s) of this Article.

...[skipping (t) through end of section 1605.3]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c) and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1606. Filing by Manufacturers; Listing of Appliances in the MAEDbS.

(a) Filing of Statements.

Each manufacturer shall electronically file with the Executive Director through the MAEDbS a statement for each appliance that is sold or offered for sale in California. The statement shall contain all of the information described in paragraphs (2) through (4) of this subsection and shall meet all of the requirements of paragraph (1) of this subsection and all other applicable requirements in this Article.

The effective dates of this section shall be the same as the effective dates shown in section 1605.1, 1605.2 or 1605.3 of this Article for appliances for which there is an energy efficiency, energy consumption, energy design, water efficiency, water consumption, or water design standard in section 1605.1, 1605.2, or 1605.3 of this Article. For appliances with no energy efficiency, energy consumption, energy design, water efficiency, water consumption, or water design standard in section 1605.1, 1605.2, or 1605.3 of this Article, the effective date of this section shall be one year after they are added to section 1601 of this Article, unless a different effective date is specified.

Exceptions to Section 1606(a) of this Article: Section 1606(a) of this Article is not applicable to:

1. external power supplies,

~~2. compressors,~~

~~*3. portable air conditioners (except for spot air conditioners),*~~

2~~4~~. small electric motors, or

3~~5~~. à la carte chargers meeting the EXCEPTION noted in section 1605.3(w)(2) of this Article.

...[skipping (a)(1) through (a)(2)]

(3) **Testing and Performance Information.**

(A) A statement that the appliance has been tested in accordance with all applicable requirements of sections 1603 and 1604 of this Article. If section 1604 of this Article provides more than one test method that may be used, the manufacturer shall identify which method was used.

Exception 1. to Section 1606(a)(3)(A) of this Article:

For state-regulated compressors, the manufacturer shall submit a statement that the appliance has been tested in accordance with all applicable requirements of sections 1603 and 1604 of this Article, or that the appliance has been rated according to an alternative efficiency determination method (AEDM) in accordance with all applicable requirements of section 1604(s) of this Article.

(B) The name and address and, if available, telephone number, fax number, URL (web site) address, and e-mail address of the laboratory or other institution where the testing required by sections 1603 and 1604 of this Article was performed.

(C) The applicable information listed in Table X; provided, however, that submittal of information marked with "[1]" is voluntary for federally regulated appliances, and that submittal of information marked with "[2]" is voluntary for state-regulated appliances. Where there is text in the "Permissible Answers" column, the information provided must be one of the answers shown. If the text in the "Permissible Answers" column states "other (specify)," the information provided must be a specific response for the "Required Information" category (e.g., a response of "other" is not acceptable).

Exception 1. to Section 1606(a)(3)(C) of this Article:

If an appliance has an alternative test procedure pursuant to section 1603(c)(1) of this Article, or an alternative assessment method specified pursuant to section 1603(c)(2)(A) of this Article, then the statement shall include:

(1) the following information from Table X: Manufacturer's Name, Brand Name, Model Number, and Regulatory Status; and
(2) all information from Table X that is applicable to the appliance and that is produced during the alternative test procedure or the alternative assessment method; and
(3) all other energy performance information produced during the alternative test procedure or the alternative assessment method.

Exception 2. to Section 1606(a)(3)(C) of this Article:

If the Executive Director has specified that there is no test method for an appliance pursuant to section 1603(c)(2)(B) of this Article, then the statement shall include the following information from Table X: Manufacturer's Name, Brand Name, Model Number, and Regulatory Status.

EXCEPTION 3. to Section 1606(a)(3)(C) of this Article:

Manufacturers of state-regulated LED lamps and LED versions of state-regulated small-diameter directional lamps may certify estimated values for rated lifetime until testing per section 1604 is complete. When reporting estimated values, the certification report shall describe the prediction method, which must be generally representative of the

methods specified in 10 C.F.R. Appendix BB to subpart B of part 430, "Uniform Test Method for Measuring the Input Power, Lumen Output, Lamp Efficacy, Correlated Color Temperature (CCT), Color Rendering Index (CRI), Power Factor, Time to Failure, and Standby Mode Power of Integrated Light-Emitting Diode (LED) Lamps." Manufacturers shall maintain records of the development of all estimated values and any associated initial test data. Manufacturers shall update the certification in the MAEDbS upon completion of the required test procedures for rated lifetime.

(D) **How Tested Data Must Be Reported.**

1. For any numerical value required by Table X that is produced by a test specified in section 1604 of this Article, the reported value shall be no higher for the value for which the consumer would prefer a high number, and no lower for the value for which the consumer would prefer a low number, than the values obtained by testing; unless different specific instructions are specified in the test method specified in section 1604 of this Article.

2. For any numerical value required by Table X that is produced by calculation from measured numerical test results, the reported value shall be no higher for the values where the consumer would prefer a high number than the exact result of the calculation, and no lower than the exact result of the calculation where the consumer would prefer a low number, than the values obtained by calculating, unless different specific instructions are specified in the test method specified in section 1604 of this Article.

3. Manufacturers may report:

    a. numbers higher than tested values, where the consumer would, all other things being equal, prefer lower values (or is indifferent); and

    b. numbers lower than tested values, where the consumer would, all other things being equal, prefer higher values (or is indifferent).

Example: An air conditioner is tested using the appropriate test method specified in section 1604 of this Article, and the test method does not include specific instructions about the precision of reporting.

- Cooling capacity is measured as: 36,014 Btu per hour.
- For cooling capacity, consumers prefer higher values.
- The manufacturer may not report any value over 36,014 Btu per hour.
- The manufacturer chooses to report 36,000 Btu per hour.
- Electrical energy use is measured at 3,487 watts.
- For electrical energy use, consumers prefer lower values.
- The manufacturer may not report any value under 3,487 watts.

- The manufacturer chooses to report 3,500 watts.
- Using the data the manufacturer chooses to report, EER = 36,000/3,500 = 10.285714.
- For EER, consumers prefer higher values.
- The manufacturer may not report any value of EER over 10.285714 (if EER is reported with only one decimal place, the maximum value would be 10.2).
- The manufacturer chooses to report EER = 10.2 Btu per watt hour.
- If the manufacturer had chosen to report the cooling capacity as 36,014 Btu per hour, and the electrical energy use as 3,487 watts, the calculated EER would have been 36,014/3,487 = 10.328076. In this case the manufacturer could not report any value of EER over 10.328076 (if EER is reported with only one decimal place, the maximum value would be 10.3).

Table X
Data Submittal Requirements

	Appliance	*Required Information*	*Permissible Answers*
	All Appliances	*Manufacturer's Name	
		* Brand Name	
		* Model Number	
		Date model to be displayed	
		Regulatory Status	Federally regulated consumer product, federally regulated commercial and industrial equipment, non-federally regulated

...[skipping A through S-Electric Motors]

	Appliance	*Required Information*	*Permissible Answers*
S	State-regulated Compressors	Isentropic Efficiency	
		Equipment Class	Rotary, lubricated, air-cooled, fixed-speed compressor; Rotary, lubricated, air-cooled, variable-speed compressor; Rotary lubricated, liquid-cooled, fixed-speed compressor; Rotary, lubricated, liquid-cooled, variable-speed compressor
		Full-load package isentropic efficiency (fixed-speed compressor only) or part-load package isentropic efficiency (variable-speed compressor only)	
		Full-load actual volume flow rate (CFM)	
		Compressor motor nominal horsepower (HP)	
		Full-load operating pressure (psig)	
		Maximum full-flow operating pressure (psig)	
		Pressure ratio at full-load operating pressure	

...[skipping T through end of Table X]

(4) **Declaration.**

(A) Each statement shall include a declaration, executed under penalty of perjury of the laws of California, that

1. all the information provided in the statement is true, complete, accurate, and in compliance with all applicable provisions of this Article;

2. the requirements of section 1606(g) of this Article have been and are being complied with;

3. for appliances for which there is an energy efficiency, energy consumption, energy design, water efficiency, water consumption, or water design standard in section 1605.1, 1605.2, or 1605.3 of this Article, that the appliance complies with the applicable standards;

4. the appliance was tested under the applicable test method specified in section 1604 of this Article, and, for the following appliances, was tested as follows:

   a. for other self-contained commercial refrigerators, refrigerator-freezers, and freezers with doors that are pass-through and roll-through refrigerators and freezers, that the back (loading) doors remained closed throughout the test;

   b. for all refrigerators, refrigerator-freezers, and freezers were tested using alternating current electricity only;

   c. for all split system central air conditioners and compressor-containing units, these models were tested with the combination of compressor-containing and non-compressor containing unit specified in 10 C.F.R. section 429.16(b)(2);

   d. for all gas-fired air conditioners and gas-fired heat pumps, all appliances were tested to ANSI Z21.40.4-1996 as modified by CEC, Efficiency Calculation method for Gas-Fired Heat Pumps as a New Compliance Option (1996);

   e. for evaporative coolers, all appliances were tested to the applicable test method referenced in Table D-3 with the modifications appearing in Table D-3;

   f. for whole house fans, all appliances were tested to HVI-916, and if equipped with louvers were tested with manufacturer-provided louvers in place;

   g. for battery charger systems for which certification is based on testing of representative battery charger system models, the models tested as representative are those known or expected to have the poorest performance characteristics such that the data generated meets the requirements of section 1606(a)(3)(D) of this Article for all associated models; and

   h. for kitchen faucets that utilize an optional and temporary higher flow rate than 1.8 gpm, the higher flow rate has been tested utilizing the test procedure identified for kitchen faucets in section 1604(h) at 60 psi and verified to have a flow rate less than or equal to 2.2 gpm.

i. for state-regulated compressors that are rated using an alternative efficiency determination method (AEDM) in lieu of testing, that the represented value of efficiency, consumption, or other non-energy metrics for the basic model was determined through the alternative efficiency determination method specified in section 1604(s).

...[skipping remainder of section 1606]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-25402(c), and 25960, Public Resources Code; and sections 16, 26, and 30, Governor's Exec. Order No. B-29-15 (April 1, 2015). Reference: Sections 25216.5(d), 25402(a)-25402(c), 25402.5.4, and 25960, Public Resources Code; and section 16, Governor's Exec. Order No. B-29-15 (April 1, 2015).

Section 1607. Marking of Appliances. No change

Section 1608. Compliance, Enforcement, and General Administrative Matters.

(a) General Requirements for the Sale or Installation of All Appliances.

Any unit of any appliance within the scope of section 1601 of this Article may be sold or offered for sale in California only if:

(1) the appliance appears in the most recent MAEDbS established pursuant to section 1606(c) of this Article, unless the only reason for the appliance's absence from the MAEDbS is its failure to comply with an applicable standard in section 1605.1 of this Article;

(2) the manufacturer has:

(A) tested the appliance as required by sections 1603 and 1604 of this Article;

(B) marked the unit as required by section 1607 of this Article;

(C) for any appliance for which there is an applicable standard in section 1605.2 or 1605.3 of this Article, certified under section 1606(a) of this Article that the appliance complies with the standard;

(3) the unit has the same components, design characteristics, and all other features that affect energy or water consumption or energy or water efficiency, as applicable, as the units that were tested under sections 1603 and 1604 of this Article and for which information was submitted under section 1606(a) of this Article; and

(4) for any appliance for which there is an applicable standard in section 1605.2 or 1605.3 of this Article, the unit complies with the standard.

Exceptions to Sections 1608(a)(1) and 1608(a)(2)(C) of this Article. Sections 1608(a)(1) and 1608(a)(2)(C) of this Article are not applicable to:

1. external power supplies,
~~2. compressors,~~
~~*3. portable air conditioners (except for spot air conditioners),*~~
2~~4~~. small electric motors, or
3~~5~~. à la carte chargers meeting the EXCEPTION noted in section 1605.3(w)(2) of this Article.

...[skipping (b) through end of section 1608]

Note: Authority cited: Sections 25213, 25218(e), 25402(a)-(c), and 25960, Public Resources Code. Reference: Sections 25216.5(d), 25402(a)-(c), and 25960, Public Resources Code.

Section 1609. Administrative Civil Penalties - No change

Title 10: Energy
PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT
Subpart B—Certification

§429.63 Compressors.

(a) *Determination of represented value.* Manufacturers must determine the represented value, which includes the certified rating, for each basic model of compressor either by testing in conjunction with the applicable sampling provisions or by applying an AEDM.

(1) *Units to be tested.* (i) If the represented value is determined through testing, the general requirements of §429.11 apply; and

(ii) For each basic model selected for testing, a sample of sufficient size must be randomly selected and tested to ensure that—

(A) *Measures of energy efficiency.* Any represented value of the full- or part-load package isentropic efficiency or other measure of energy efficiency of a basic model for which customers would favor higher values is less than or equal to the lower of:

(*1*) The mean of the sample, where:

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

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

(*2*) The lower 95 percent confidence limit (LCL) of the true mean divided by 0.95, where:

$$LCL = \bar{x} - t_{0.95}\left(\frac{s}{\sqrt{n}}\right)$$

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And $\bar{x}$ is the sample mean; s is the sample standard deviation; n is the number of samples; and $t_{0.95}$ is the t statistic for a 95 percent one-tailed confidence interval with n−1 degrees of freedom (from appendix A of this subpart); and

(B) *Package specific power.* The representative value(s) of package specific power of a basic model must be the mean of the package specific power measurement(s) for each tested unit of the basic model.

(2) *Alternative efficiency determination methods.* In lieu of testing, any represented value of efficiency, consumption, or other non-energy metrics listed in paragraph (a)(3) of this section for a basic model may be determined through the application of an AEDM pursuant to the requirements of §429.70 and the provisions of this section, where:

(i) Any represented values of package isentropic efficiency or other measure of energy consumption of a basic model for which customers would favor higher values must be less than or equal to the output of the AEDM; and

(ii) Any represented values of package specific power, pressure ratio at full-load operating pressure, full-load actual volume flow rate, or full-load operating pressure must be the output of the AEDM corresponding to the represented value of package isentropic efficiency determined in paragraph (a)(2)(i) of this section.

(3) *Representations of non-energy metrics*—(i) *Full-load actual volume flow rate.* The representative value of full-load actual volume flow rate of a basic model must be either—

(A) The mean of the full-load actual volume flow rate for the units in the sample; or

(B) As determined through the application of an AEDM pursuant to the requirements of §429.70.

(ii) *Full-load operating pressure.* The representative value of full-load operating pressure of a basic model must be less than or equal to the maximum full-flow operating pressure and greater than or equal to the lesser of—

(A) 90 percent of the maximum full-flow operating pressure; or

(B) 10 psig less than the maximum full-flow operating pressure, where the maximum full-flow operating pressure must either be determined as the mean of the maximum full-flow operating pressure values for the units in the sample or through the application of an AEDM pursuant to the requirements of §429.70.

(iii) *Pressure ratio at full-load operating pressure.* The representative value of pressure ratio at full-load operating pressure of a basic model must be either be determined as the mean of the pressure ratio at full-load operating pressure for the units in the sample or through the application of an AEDM pursuant to the requirements of §429.70.

(b) [Reserved]

[82 FR 1099, Jan. 4, 2017]

Title 10: Energy
PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT
Subpart B—Certification

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§429.70 Alternative methods for determining energy efficiency and energy use.

(a) *General applicability of an AEDM.* A manufacturer of covered products or covered equipment explicitly authorized to use an AEDM in §§429.14 through 429.62 may not distribute any basic model of such equipment in commerce unless the manufacturer has determined the energy efficiency of the basic model, either from testing the basic model in conjunction with DOE's certification sampling plans and statistics or from applying an alternative method for determining energy efficiency or energy use (AEDM) to the basic model, in accordance with the requirements of this section. In instances where a manufacturer has tested a basic model, the manufacturer may not knowingly use an AEDM to overrate the efficiency (or underrate the consumption) of the model.

(b) *Testing.* Testing for each covered product or covered equipment must be done in accordance with the sampling plan provisions established in §429.11 and the testing procedures in parts 430 and 431 of this chapter.

(c) *Alternative efficiency determination method (AEDM) for commercial HVAC (includes commercial warm air furnaces and commercial packaged boilers), WH, and refrigeration equipment*—(1) *Criteria an AEDM must satisfy.* A manufacturer may not apply an AEDM to a basic model to determine its efficiency pursuant to this section unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the basic model as measured by the applicable DOE test procedure;

(ii) The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data; and

(iii) The manufacturer has validated the AEDM, in accordance with paragraph (c)(2) of this section with basic models that meet the current Federal energy conservation standards.

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability as follows:

(i) The manufacturer must select at least the minimum number of basic models for each validation class specified in paragraph (c)(2)(iv) of this section to which the particular AEDM applies. Using the AEDM, calculate the energy use or efficiency for each of the selected basic models. Test a single unit of each selected basic model in accordance with paragraph (c)(2)(iii) of this section. Compare the results from the single unit test and the AEDM energy use or efficiency output according to paragraph (c)(2)(ii) of this section. The manufacturer is responsible for ensuring the accuracy and reliability of the AEDM.

(ii) *Individual model tolerances.* (A) For those covered products with an energy-efficiency metric, the predicted efficiency for each model calculated by applying the AEDM may not be more than five percent greater than the efficiency determined from the corresponding test of the model.

(B) For those covered products with an energy-consumption metric, the predicted energy consumption for each model, calculated by applying the AEDM, may not be more than five percent less than the energy consumption determined from the corresponding test of the model.

(C) For all covered products, the predicted energy efficiency or consumption for each model calculated by applying the AEDM must meet or exceed the applicable federal energy conservation performance standard.

(D) An AEDM that is validated based on test results obtained from one or more field tests (pursuant to §431.86(c)) can only be used to certify the performance of basic models of commercial packaged boilers with a certified rated input greater than 5,000,000 Btu/h.

(iii) *Additional test unit requirements.* (A) Each AEDM must be supported by test data obtained from physical tests of current models; and

(B) Test results used to validate the AEDM must meet or exceed current, applicable Federal standards as specified in part 431 of this chapter; and

(C) Each test must have been performed in accordance with the DOE test procedure specified in parts 430 or 431 of this chapter or test procedure waiver for which compliance is required at the time the basic model is distributed in commerce.

(iv) *Validation classes.*

Validation class	Minimum number of distinct models that must be tested per AEDM
Air-Cooled, Split and Packaged Air Conditioners (ACs) and Heat Pumps (HPs) less than 65,000 Btu/h Cooling Capacity (3-Phase)	2 Basic Models.
(A) Commercial HVAC validation classes	
Air-Cooled, Split and Packaged ACs and HPs greater than or equal to 65,000 Btu/h Cooling Capacity and Less than 760,000 Btu/h Cooling Capacity	2 Basic Models.
Water-Cooled, Split and Packaged ACs and HPs, All Cooling Capacities	2 Basic Models.
Evaporatively-Cooled, Split and Packaged ACs and HPs, All Capacities	2 Basic Models.
Water-Source HPs, All Capacities	2 Basic Models.
Single Package Vertical ACs and HPs	2 Basic Models.
Packaged Terminal ACs and HPs	2 Basic Models.
Air-Cooled, Variable Refrigerant Flow ACs and HPs	2 Basic Models.
Water-Cooled, Variable Refrigerant Flow ACs and HPs	2 Basic Models.
Computer Room Air Conditioners, Air Cooled	2 Basic Models.
Computer Room Air Conditioners, Water-Cooled	2 Basic Models.
(B) Commercial water heater validation classes	
Gas-fired Water Heaters and Hot Water Supply Boilers Less than 10 Gallons	2 Basic Models.
Gas-fired Water Heaters and Hot Water Supply Boilers Greater than or Equal to 10 Gallons	2 Basic Models.
Oil-fired Water Heaters and Hot Water Supply Boilers Less than 10 Gallons	2 Basic Models.
Oil-fired Water Heaters and Hot Water Supply Boilers Greater than or Equal to 10 Gallons	2 Basic Models.
Electric Water Heaters	2 Basic Models.
Heat Pump Water Heaters	2 Basic Models.
Unfired Hot Water Storage Tanks	2 Basic Models.
(C) Commercial packaged boilers validation classes	
Gas-fired, Hot Water Only Commercial Packaged Boilers	2 Basic Models.
Gas-fired, Steam Only Commercial Packaged Boilers	2 Basic Models.
Gas-fired Hot Water/Steam Commercial Packaged Boilers	2 Basic Models.
Oil-fired, Hot Water Only Commercial Packaged Boilers	2 Basic Models.
Oil-fired, Steam Only Commercial Packaged Boilers	2 Basic Models.
Oil-fired Hot Water/Steam Commercial Packaged Boilers	2 Basic Models.
(D) Commercial furnace validation classes	
Gas-fired Furnaces	2 Basic Models.
Oil-fired Furnaces	2 Basic Models.
(E) Commercial refrigeration equipment validation classes	
Self-Contained Open Refrigerators	2 Basic Models.

Self-Contained Open Freezers	2 Basic Models.
Remote Condensing Open Refrigerators	2 Basic Models.
Remote Condensing Open Freezers	2 Basic Models.
Self-Contained Closed Refrigerators	2 Basic Models.
Self-Contained Closed Freezers	2 Basic Models.
Remote Condensing Closed Refrigerators	2 Basic Models.
Remote Condensing Closed Freezers	2 Basic Models.

[1]The minimum number of tests indicated above must be comprised of a transparent model, a solid model, a vertical model, a semi-vertical model, a horizontal model, and a service-over-the counter model, as applicable based on the equipment offering. However, manufacturers do not need to include all types of these models if it will increase the minimum number of tests that need to be conducted.

(3) *AEDM records retention requirements.* If a manufacturer has used an AEDM to determine representative values pursuant to this section, the manufacturer must have available upon request for inspection by the Department records showing:

(i) The AEDM, including the mathematical model, the engineering or statistical analysis, and/or computer simulation or modeling that is the basis of the AEDM;

(ii) Product information, complete test data, AEDM calculations, and the statistical comparisons from the units tested that were used to validate the AEDM pursuant to paragraph (c)(2) of this section; and

(iii) Product information and AEDM calculations for each basic model to which the AEDM has been applied.

(4) *Additional AEDM requirements.* If requested by the Department and at DOE's discretion, the manufacturer must perform at least one of the following:

(i) Conduct simulations before representatives of the Department to predict the performance of particular basic models of the product to which the AEDM was applied;

(ii) Provide analyses of previous simulations conducted by the manufacturer; or

(iii) Conduct certification testing of basic models selected by the Department.

(5) *AEDM verification testing.* DOE may use the test data for a given individual model generated pursuant to §429.104 to verify the certified rating determined by an AEDM as long as the following process is followed:

(i) *Selection of units.* DOE will obtain units for test from retail, where available. If units cannot be obtained from retail, DOE will request that a unit be provided by the manufacturer;

(ii) *Lab requirements.* DOE will conduct testing at an independent, third-party testing facility of its choosing. In cases where no third-party laboratory is capable of testing the equipment, it may be tested at a manufacturer's facility upon DOE's request.

(iii) *Manufacturer participation.* (A) Except when testing variable refrigerant flow systems (which are governed by the rules found at §431.96(f)), testing will be completed without a manufacturer representative on-site. In limited instances further described in paragraph (c)(5)(iii)(B) of this section, a manufacturer and DOE representative may be present to witness the test set-up.

(B) A manufacturer's representative may request to be on-site to witness the test set-up if:

(*1*) The installation manual for the basic model specifically requires it to be started only by a factory-trained installer; or

(*2*) The manufacturer has elected, as part of the certification of that basic model, to have the opportunity to witness the test set-up. A manufacturer may elect to witness the test set-up for the initial verification test for no more than 10 percent of the manufacturer's basic models submitted for certification and rated with an AEDM per validation class specified in section (c)(2)(iv) of this paragraph. The 10-percent limit applies to all of the eligible basic models submitted for certification by a given manufacturer no matter how many AEDMs a manufacturer has used to develop

its ratings. The 10-percent limit is determined by first calculating 10 percent of the total number of basic models rated with an AEDM per validation class, and then truncating the resulting product. Manufacturers who have submitted fewer than 10 basic models rated with an AEDM for certification may elect to have the opportunity to witness the test set-up of one basic model. A manufacturer must identify the basic models it wishes to witness as part of its certification report(s) prior to the basic model being selected for verification testing.

(*3*) In those instances in which a manufacturer has not provided the required information as specified in §429.12(b)(13) for a given basic model that has been rated and certified as compliant with the applicable standards, a manufacturer is precluded from witnessing the testing set up for that basic model.

(C) A DOE representative will be present for the test set-up in all cases where a manufacturer representative requests to be on-site for the test set-up. The manufacturer's representative cannot communicate with a lab representative outside of the DOE representative's presence.

(D) If DOE has obtained through retail channels a unit for test that meets either of the conditions in paragraph (c)(5)(iii)(B) of this section, DOE will notify the manufacturer that the basic model was selected for testing and that the manufacturer may have a representative present for the test set-up. If the manufacturer does not respond within five calendar days of receipt of that notification, the manufacturer waives the option to be present for test set-up, and DOE will proceed with the test set-up without a manufacturer's representative present.

(E) If DOE has obtained directly from the manufacturer a unit for test that meets either of the conditions in paragraph (c)(5)(iii)(B) of this section, DOE will notify the manufacturer of the option to be present for the test set-up at the time the unit is purchased. DOE will specify the date (not less than five calendar days) by which the manufacturer must notify DOE whether a manufacturer's representative will be present. If the manufacturer does not notify DOE by the date specified, the manufacturer waives the option to be present for the test set-up, and DOE will proceed with the test set-up without a manufacturer's representative present.

(F) DOE will review the certification submissions from the manufacturer that were on file as of the date DOE purchased a basic model (under paragraph (c)(5)(iii)(D) of this section) or the date DOE notifies the manufacturer that the basic model has been selected for testing (under paragraph (c)(5)(iii)(E) of this section) to determine if the manufacturer has indicated that it intends to witness the test set-up of the selected basic model. DOE will also verify that the manufacturer has not exceeded the allowable limit of witness testing selections as specified in paragraph (c)(5)(iii)(B)(*2*) of this section. If DOE discovers that the manufacturer exceeded the limits specified in paragraph (c)(5)(iii)(B)(*2*), DOE will notify the manufacturer of this fact and deny its request to be present for the test set-up of the selected basic model. The manufacturer must update its certification submission to ensure it has not exceeded the allowable limit of witness testing selections as specified in paragraph (c)(5)(iii)(B)(*2*) to be present at set-up for future selections. At this time DOE will also review the supplemental PDF submission(s) for the selected basic model to determine that all necessary information has been provided to the Department.

(G) If DOE determines, pursuant to paragraph (c)(5)(ii) of this section, that the model should be tested at the manufacturer's facility, a DOE representative will be present on site to observe the test set-up and testing with the manufacturer's representative. All testing will be conducted at DOE's direction, which may include DOE-contracted personnel from a third-party lab, as well as the manufacturer's technicians.

(H) As further explained in paragraph (c)(5)(v)(B) of this section, if a manufacturer's representative is present for the initial test set-up for any reason, the manufacturer forfeits any opportunity to request a retest of the basic model. Furthermore, if the manufacturer requests to be on-site for test set-up pursuant to paragraph (c)(5)(iii)(B) of this section but is not present on site, the manufacturer forfeits any opportunity to request a retest of the basic model.

(iv) *Testing.* At no time during verification testing may the lab and the manufacturer communicate without DOE authorization. All verification testing will be conducted in accordance with the applicable DOE test procedure, as well as each of the following to the extent that they apply:

(A) Any active test procedure waivers that have been granted for the basic model;

(B) Any test procedure guidance that has been issued by DOE;

(C) The installation and operations manual that is shipped with the unit;

(D) Any additional information that was provided by the manufacturer at the time of certification (prior to DOE obtaining the unit for test); and

(E) If during test set-up or testing, the lab indicates to DOE that it needs additional information regarding a given basic model in order to test in accordance with the applicable DOE test procedure, DOE may organize a meeting between DOE, the manufacturer and the lab to provide such information.

(v) *Failure to meet certified rating.* If a model tests worse than its certified rating by an amount exceeding the tolerance prescribed in paragraph (c)(5)(vi) of this section, DOE will notify the manufacturer. DOE will provide the manufacturer with all documentation related to the test set up, test conditions, and test results for the unit. Within the timeframe allotted by DOE, the manufacturer may then:

(A) Present all claims regarding testing validity; and

(B) If the manufacturer was not on site for the initial test set-up, request a retest of the previously tested unit with manufacturer and DOE representatives on-site for the test set-up. DOE will not conduct the retest using a different unit of the same basic model unless DOE and the manufacturer determine it is necessary based on the test results, claims presented, and DOE regulations.

(vi) *Tolerances.* (A) For consumption metrics, the result from a DOE verification test must be less than or equal to the certified rating × (1 + the applicable tolerance).

(B) For efficiency metrics, the result from a DOE verification test must be greater than or equal to the certified rating × (1 − the applicable tolerance).

Equipment	Metric	Applicable tolerance
Commercial Packaged Boilers	Combustion Efficiency Thermal Efficiency	5% (0.05) 5% (0.05)
Commercial Water Heaters or Hot Water Supply Boilers	Thermal Efficiency Standby Loss	5% (0.05) 10% (0.1)
Unfired Storage Tanks	R-Value	10% (0.1)
Air-Cooled, Split and Packaged ACs and HPs less than 65,000 Btu/h	Seasonal Energy-Efficiency Ratio	5% (0.05)
Cooling Capacity (3-Phase)	Heating Season Performance Factor Energy Efficiency Ratio	5% (0.05) 10% (0.1)
Air-Cooled, Split and Packaged ACs and HPs greater than or equal to 65,000 Btu/h Cooling Capacity and Less than 760,000 Btu/h Cooling Capacity	Energy Efficiency Ratio Coefficient of Performance Integrated Energy Efficiency Ratio	5% (0.05) 5% (0.05) 10% (0.1)
Water-Cooled, Split and Packaged ACs and HPs, All Cooling Capacities	Energy Efficiency Ratio Coefficient of Performance Integrated Energy Efficiency Ratio	5% (0.05) 5% (0.05) 10% (0.1)
Evaporatively-Cooled, Split and Packaged ACs and HPs, All Capacities	Energy Efficiency Ratio Coefficient of Performance	5% (0.05) 5% (0.05) 10% (0.1)

	Integrated Energy Efficiency Ratio	
Water-Source HPs, All Capacities	Energy Efficiency Ratio Coefficient of Performance Integrated Energy Efficiency Ratio	5% (0.05) 5% (0.05) 10% (0.1)
Single Package Vertical ACs and HPs	Energy Efficiency Ratio Coefficient of Performance	5% (0.05) 5% (0.05)
Packaged Terminal ACs and HPs	Energy Efficiency Ratio Coefficient of Performance	5% (0.05) 5% (0.05)
Variable Refrigerant Flow ACs and HPs	Energy Efficiency Ratio Coefficient of Performance Integrated Energy Efficiency Ratio	5% (0.05) 5% (0.05) 10% (0.1)
Computer Room Air Conditioners	Sensible Coefficient of Performance	5% (0.05)
Commercial Warm-Air Furnaces	Thermal Efficiency	5% (0.05)
Commercial Refrigeration Equipment	Daily Energy Consumption	5% (0.05)

(vii) *Invalid rating.* If, following discussions with the manufacturer and a retest where applicable, DOE determines that the verification testing was conducted appropriately in accordance with the DOE test procedure, DOE will issue a determination that the rating for the model is invalid. The manufacturer must elect, within 15 days, one of the following to be completed in a time frame specified by DOE, which is never to exceed 180 days:

(A) Re-rate and re-certify the model based on DOE's test data alone; or

(B) Discontinue the model through the certification process; or

(C) Conduct additional testing and re-rate and re-certify the basic model based on all test data collected, including DOE's test data.

(viii) *AEDM use.* (A) If DOE has determined that a manufacturer made invalid ratings on two or more models rated using the same AEDM within a 24 month period, the manufacturer must take the action listed in the table corresponding to the number of invalid certified ratings. The twenty-four month period begins with a DOE determination that a rating is invalid through the process outlined above. Additional invalid ratings apply for the purposes of determining the appropriate consequences if the subsequent determination(s) is based on selection of a unit for testing within the twenty-four month period (i.e., subsequent determinations need not be made within 24 months).

Number of invalid certified ratings from the same AEDM[2] within a rolling 24 month period[3]	**Required manufacturer actions**

2	Submit different test data and reports from testing to validate that AEDM within the validation classes to which it is applied.[1] Adjust the ratings as appropriate.
4	Conduct double the minimum number of validation tests for the validation classes to which the AEDM is applied. Note, the tests required under this paragraph (c)(5)(viii) must be performed on different models than the original tests required under paragraph (c)(2) of this section.
6	Conduct the minimum number of validation tests for the validation classes to which the AEDM is applied at a third-part test facility; And Conduct addition testing, which is equal to ½ the minimum number of validation tests for the validation classes to which the AEDM is applied , at either the manufacturer's facility or a third-party test facility, at the manufacturer's discretion.
	Note, the tests required under this paragraph (c)(5)(viii) must be performed on different models than the original tests performed under paragraph (c)(2) of this section.
> = 8	Manufacturer has lost privilege to use AEDM. All ratings for models within the validation classes to which the AEDM applied should be rated via testing. Distribution cannot continue until certification(s) are corrected to reflect actual test data.

[1]A manufacturer may discuss with DOE's Office of Enforcement whether existing test data on different basic models within the validation classes to which that specific AEDM was applied may be used to meet this requirement.

[2]The "same AEDM" means a computer simulation or mathematical model that is identified by the manufacturer at the time of certification as having been used to rate a model or group of models.

[3]The twenty-four month period begins with a DOE determination that a rating is invalid through the process outlined above. Additional invalid ratings apply for the purposes of determining the appropriate consequences if the subsequent determination(s) is based on testing of a unit that was selected for testing within the twenty-four month period (i.e., subsequent determinations need not be made within 24 months).

(B) If, as a result of eight or more invalid ratings, a manufacturer has lost the privilege of using an AEDM for rating, the manufacturer may regain the ability to use an AEDM by:

(*1*) Investigating and identifying cause(s) for failures;

(*2*) Taking corrective action to address cause(s);

(*3*) Performing six new tests per validation class, a minimum of two of which must be performed by an independent, third-party laboratory to validate the AEDM; and

(*4*) Obtaining DOE authorization to resume use of the AEDM.

(d) *Alternative efficiency determination method for distribution transformers*—A manufacturer may use an AEDM to determine the efficiency of one or more of its untested basic models only if it determines the efficiency of at least five of its other basic models (selected in accordance with paragraph (d)(3) of this section) through actual testing.

(1) *Criteria an AEDM must satisfy.*

(i) The AEDM has been derived from a mathematical model that represents the electrical characteristics of that basic model;

(ii) The AEDM is based on engineering and statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data; and

(iii) The manufacturer has substantiated the AEDM, in accordance with paragraph (d)(2) of this section, by applying it to, and testing, at least five other basic models of the same type, *i.e.,* low-voltage dry-type distribution

transformers, medium-voltage dry-type distribution transformers, or liquid-immersed distribution transformers.

(2) *Substantiation of an AEDM.* Before using an AEDM, the manufacturer must substantiate the AEDM's accuracy and reliability as follows:

(i) Apply the AEDM to at least five of the manufacturer's basic models that have been selected for testing in accordance with paragraph (d)(3) of this section, and calculate the power loss for each of these basic models;

(ii) Test at least five units of each of these basic models in accordance with the applicable test procedure and §429.47, and determine the power loss for each of these basic models;

(iii) The predicted total power loss for each of these basic models, calculated by applying the AEDM pursuant to paragraph (d)(2)(i) of this section, must be within plus or minus five percent of the mean total power loss determined from the testing of that basic model pursuant to paragraph (d)(2)(ii) of this section; and

(iv) Calculate for each of these basic models the percentage that its power loss calculated pursuant to paragraph (d)(2)(i) of this section is of its power loss determined from testing pursuant to paragraph (d)(2)(ii) of this section, compute the average of these percentages, and that calculated average power loss, expressed as a percentage of the average power loss determined from testing, must be no less than 97 percent and no greater than 103 percent.

(3) *Additional testing requirements.* (i) A manufacturer must select basic models for testing in accordance with the following criteria:

(A) Two of the basic models must be among the five basic models with the highest unit volumes of production by the manufacturer in the prior year, or during the prior 12-calendar-month period beginning in 2003,[1] whichever is later;

[1]When identifying these five basic models, any basic model that does not comply with Federal energy conservation standards for distribution transformers that may be in effect shall be excluded from consideration.

(B) No two basic models should have the same combination of power and voltage ratings; and

(C) At least one basic model should be single-phase and at least one should be three-phase.

(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.

(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:

(A) The method or methods used;

(B) 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;

(C) Complete test data, product information, and related information that the manufacturer has generated or acquired pursuant to paragraph (d)(4) of this section; and

(D) 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 must perform at least one of the following:

(A) Conduct simulations to predict the performance of particular basic models of distribution transformers specified by the Department;

(B) Provide analyses of previous simulations conducted by the manufacturer;

(C) Conduct sample testing of basic models selected by the Department; or

(D) Conduct a combination of these.

(e) *Alternate Efficiency Determination Method (AEDM) for central air conditioners and heat pumps.* This paragraph (e) sets forth the requirements for a manufacturer to use an AEDM to rate central air conditioners and heat pumps.

(1) *Criteria an AEDM must satisfy.* A manufacturer may not apply an AEDM to an individual model/combination to determine its represented values (SEER, EER, HSPF, SEER2, EER2, HSPF2, and/or $P_{W,OFF}$) pursuant to this section unless authorized pursuant to §429.16(d) and:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the individual model or combination (SEER, EER, HSPF, SEER2, EER2, HSPF2, and/or $P_{W,OFF}$) as measured by the applicable DOE test procedure; and

(ii) The manufacturer has validated the AEDM in accordance with paragraph (e)(2) of this section.

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability as follows:

(i) Follow paragraph (e)(2)(i)(A) of this section for requirements on minimum testing. Follow paragraph (e)(2)(i)(B) of this section for requirements on ensuring the accuracy and reliability of the AEDM.

(A) *Minimum testing.* (*1*) For non-space-constrained single-split system air conditioners and heat pumps rated based on testing in accordance with appendix M to subpart B of part 430, the manufacturer must test each basic model as required under §429.16(b)(2). Until July 1, 2024, for non-space-constrained single-split-system air conditioners and heat pumps rated based on testing in accordance with appendix M1 to subpart B of part 430, the manufacturer must test a single-unit sample from 20 percent of the basic models distributed in commerce to validate the AEDM. On or after July 1, 2024, for non-space-constrained single-split-system air conditioners and heat pumps rated based on testing in accordance with appendix M1 to subpart B of part 430, the manufacturer must complete testing of each basic model as required under §429.16(b)(2).

(*2*) For other than non-space-constrained single-split-system air conditioners and heat pumps, the manufacturer must test each basic model as required under §429.16(b)(2).

(B) Using the AEDM, calculate the energy use or efficiency for each of the tested individual models/combinations within each basic model. Compare the represented value based on testing and the AEDM energy use or efficiency output according to paragraph (e)(2)(ii) of this section. The manufacturer is responsible for ensuring the accuracy and reliability of the AEDM and that their representations are appropriate and the models being distributed in commerce meet the applicable standards, regardless of the amount of testing required in paragraphs (e)(2)(i)(A) and (e)(2)(i)(B) of this section.

(ii) *Individual model/combination tolerances.* This paragraph (e)(2)(ii) provides the tolerances applicable to individual models/combinations rated using an AEDM.

(A) The predicted represented values for each individual model/combination calculated by applying the AEDM may not be more than four percent greater (for measures of efficiency) or less (for measures of consumption) than the values determined from the corresponding test of the individual model/combination.

(B) The predicted energy efficiency or consumption for each individual model/combination calculated by applying the AEDM must meet or exceed the applicable federal energy conservation standard.

(iii) *Additional test unit requirements.* (A) Each AEDM must be supported by test data obtained from physical tests of current individual models/combinations; and

(B) Test results used to validate the AEDM must meet or exceed current, applicable Federal standards as specified in part 430 of this chapter; and

(C) Each test must have been performed in accordance with the applicable DOE test procedure with which compliance is required at the time the individual models/combinations used for validation are distributed in commerce.

(3) *AEDM records retention requirements.* If a manufacturer has used an AEDM to determine representative values pursuant to this section, the manufacturer must have available upon request for inspection by the Department records showing:

(i) The AEDM, including the mathematical model, the engineering or statistical analysis, and/or computer simulation or modeling that is the basis of the AEDM;

(ii) Product information, complete test data, AEDM calculations, and the statistical comparisons from the units tested that were used to validate the AEDM pursuant to paragraph (e)(2) of this section; and

(iii) Product information and AEDM calculations for each individual model/combination to which the AEDM has been applied.

(4) *Additional AEDM requirements.* If requested by the Department, the manufacturer must:

(i) Conduct simulations before representatives of the Department to predict the performance of particular individual models/combinations;

(ii) Provide analyses of previous simulations conducted by the manufacturer; and/or

(iii) Conduct certification testing of individual models or combinations selected by the Department.

(5) *AEDM verification testing.* DOE may use the test data for a given individual model/combination generated pursuant to §429.104 to verify the represented value determined by an AEDM as long as the following process is followed:

(i) *Selection of units.* DOE will obtain one or more units for test from retail, if available. If units cannot be obtained from retail, DOE will request that a unit be provided by the manufacturer;

(ii) *Lab requirements.* DOE will conduct testing at an independent, third-party testing facility of its choosing. In cases where no third-party laboratory is capable of testing the equipment, testing may be conducted at a manufacturer's facility upon DOE's request.

(iii) *Testing.* At no time during verification testing may the lab and the manufacturer communicate without DOE authorization. If during test set-up or testing, the lab indicates to DOE that it needs additional information regarding a given individual model or combination in order to test in accordance with the applicable DOE test procedure, DOE may organize a meeting between DOE, the manufacturer and the lab to provide such information.

(iv) *Failure to meet certified value.* If an individual model/combination tests worse than its certified value (*i.e.,* lower than the certified efficiency value or higher than the certified consumption value) by more than 5 percent, or the test results in cooling capacity that is lower than its certified cooling capacity, DOE will notify the manufacturer. DOE will provide the manufacturer with all documentation related to the test set up, test conditions, and test results for the unit. Within the timeframe allotted by DOE, the manufacturer may present any and all claims regarding testing validity.

(v) *Tolerances.* This paragraph specifies the tolerances DOE will permit when conducting verification testing.

(A) For consumption metrics, the result from a DOE verification test must be less than or equal to 1.05 multiplied by the certified represented value.

(B) For efficiency metrics, the result from a DOE verification test must be greater than or equal to 0.95 multiplied by the certified represented value.

(vi) *Invalid represented value.* If, following discussions with the manufacturer and a retest where applicable, DOE determines that the verification testing was conducted appropriately in accordance with the DOE test procedure, DOE will issue a determination that the represented values for the basic model are invalid. The manufacturer must conduct additional testing and re-rate and re-certify the individual models/combinations within the basic model that were rated using the AEDM based on all test data collected, including DOE's test data.

(vii) *AEDM use.* This paragraph (e)(5)(vii) specifies when a manufacturer's use of an AEDM may be restricted due to prior invalid represented values.

(A) If DOE has determined that a manufacturer made invalid represented values on individual models/combinations within two or more basic models rated using the manufacturer's AEDM within a 24 month period, the manufacturer must test the least efficient and most efficient individual model/combination within each basic model in addition to the individual model/combination specified in §429.16(b)(2). The twenty-four month period begins with a DOE determination that a represented value is invalid through the process outlined above.

(B) If DOE has determined that a manufacturer made invalid represented values on more than four basic models rated using the manufacturer's AEDM within a 24-month period, the manufacturer may no longer use an AEDM.

(C) If a manufacturer has lost the privilege of using an AEDM, the manufacturer may regain the ability to use an AEDM by:

(*1*) Investigating and identifying cause(s) for failures;

(*2*) Taking corrective action to address cause(s);

(*3*) Performing six new tests per basic model, a minimum of two of which must be performed by an independent, third-party laboratory from units obtained from retail to validate the AEDM; and

(*4*) Obtaining DOE authorization to resume use of an AEDM.

(f) *Alternative efficiency determination method (AEDM) for walk-in refrigeration equipment—*

(1) *Criteria an AEDM must satisfy.* A manufacturer may not apply an AEDM to a basic model to determine its efficiency pursuant to this section unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the basic model as measured by the applicable DOE test procedure;

(ii) The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytical evaluation of performance data; and

(iii) The manufacturer has validated the AEDM, in accordance with paragraph (f)(2) of this section.

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability as follows:

(i) The manufacturer must select at least the minimum number of basic models for each validation class specified in paragraph (f)(2)(iv) of this section to which the particular AEDM applies. Test a single unit of each basic model in accordance with paragraph (f)(2)(iii) of this section. Using the AEDM, calculate the energy use or energy efficiency for each of the selected basic models. Compare the results from the single unit test and the AEDM output according to paragraph (f)(2)(ii) of this section. The manufacturer is responsible for ensuring the accuracy and repeatability of the AEDM.

(ii) *Individual model tolerances.* (A) The predicted efficiency for each model calculated by applying the AEDM may not be more than five percent greater than the efficiency determined from the corresponding test of the model.

(B) The predicted energy efficiency for each model calculated by applying the AEDM must meet or exceed the applicable federal energy conservation standard.

(iii) *Additional test unit requirements.* (A) Each AEDM must be supported by test data obtained from physical tests of current models; and

(B) Test results used to validate the AEDM must meet or exceed current, applicable Federal standards as specified in part 431 of this chapter;

(C) Each test must have been performed in accordance with the applicable DOE test procedure with which compliance is required at the time the basic model is distributed in commerce; and

(D) For rating WICF refrigeration system components, an AEDM may not simulate or model portions of the system that are not required to be tested by the DOE test procedure. That is, if the test results used to validate the AEDM are for either a unit cooler only or a condensing unit only, the AEDM must estimate the system rating using the nominal values specified in the DOE test procedure for the other part of the refrigeration system.

(iv) *WICF refrigeration validation classes.*

Validation class	Minimum number of distinct models that must be tested
Dedicated Condensing, Medium Temperature, Indoor	2 Basic Models.

System	
Dedicated Condensing, Medium Temperature, Outdoor System[1]	2 Basic Models.
Dedicated Condensing, Low Temperature, Indoor System	2 Basic Models.
Dedicated Condensing, Low Temperature, Outdoor System[2]	2 Basic Models.
Unit Cooler connected to a Multiplex Condensing Unit, Medium Temperature	2 Basic Models.
Unit Cooler connected to a Multiplex Condensing Unit, Low Temperature	2 Basic Models.
Medium Temperature, Indoor Condensing Unit	2 Basic Models.
Medium Temperature, Outdoor Condensing Unit[3]	2 Basic Models.
Low Temperature, Indoor Condensing Unit	2 Basic Models.
Low Temperature, Outdoor Condensing Unit[4]	2 Basic Models.

[1]AEDMs validated for dedicated condensing, medium temperature, outdoor systems may be used to determine representative values for dedicated condensing, medium temperature, indoor systems, and additional validation testing is not required. AEDMs validated for only dedicated condensing, medium temperature, indoor systems may not be used to determine representative values for dedicated condensing, medium temperature, outdoor systems.

[2]AEDMs validated for dedicated condensing, low temperature, outdoor systems may be used to determine representative values for dedicated condensing, low temperature, indoor systems, and additional validation testing is not required. AEDMs validated for only dedicated condensing, low temperature, indoor systems may not be used to determine representative values for dedicated condensing, low temperature, outdoor systems.

[3]AEDMs validated for medium temperature, outdoor condensing units may be used to determine representative values for medium temperature, indoor condensing units, and additional validation testing is not required. AEDMs validated for only medium temperature, indoor condensing units may not be used to determine representative values for medium temperature, outdoor condensing units.

[4]AEDMs validated for low temperature, outdoor condensing units may be used to determine representative values for low temperature, indoor condensing units, and additional validation testing is not required. AEDMs validated for only low temperature, indoor condensing units may not be used to determine representative values for low temperature, outdoor condensing units.

(3) *AEDM records retention requirements.* If a manufacturer has used an AEDM to determine representative values pursuant to this section, the manufacturer must have available upon request for inspection by the Department records showing:

(i) The AEDM, including the mathematical model, the engineering or statistical analysis, and/or computer simulation or modeling that is the basis of the AEDM;

(ii) Equipment information, complete test data, AEDM calculations, and the statistical comparisons from the units tested that were used to validate the AEDM pursuant to paragraph (f)(2) of this section; and

(iii) Equipment information and AEDM calculations for each basic model to which the AEDM has been applied.

(4) *Additional AEDM requirements.* If requested by the Department the manufacturer must perform at least one of the following:

(i) Conduct simulations before representatives of the Department to predict the performance of particular basic models of the product to which the AEDM was applied;

(ii) Provide analyses of previous simulations conducted by the manufacturer; or

(iii) Conduct certification testing of basic models selected by the Department.

(5) *AEDM verification testing.* DOE may use the test data for a given individual model generated pursuant to §429.104 to verify the certified rating determined by an AEDM as long as the following process is followed:

(i) *Selection of units.* DOE will obtain units for test from retail, where available. If units cannot be obtained from retail, DOE will request that a unit be provided by the manufacturer.

(ii) *Lab requirements.* DOE will conduct testing at an independent, third-party testing facility of its choosing. In cases where no third-party laboratory is capable of testing the equipment, it may be tested at a manufacturer's facility upon DOE's request.

(iii) *Manufacturer participation.* Testing will be performed without manufacturer representatives on-site.

(iv) *Testing.* All verification testing will be conducted in accordance with the applicable DOE test procedure, as well as each of the following to the extent that they apply:

(A) Any active test procedure waivers that have been granted for the basic model;

(B) Any test procedure guidance that has been issued by DOE;

(C) If during test set-up or testing, the lab indicates to DOE that it needs additional information regarding a given basic model in order to test in accordance with the applicable DOE test procedure, DOE may organize a meeting between DOE, the manufacturer and the lab to provide such information.

(D) At no time during the process may the lab communicate directly with the manufacturer without DOE present.

(v) *Failure to meet certified rating.* If a model tests worse than its certified rating by an amount exceeding the tolerance prescribed in paragraph (f)(5)(vi) of this section, DOE will notify the manufacturer. DOE will provide the manufacturer with all documentation related to the test set up, test conditions, and test results for the unit. Within the timeframe allotted by DOE, the manufacturer may then present all claims regarding testing validity.

(vi) *Tolerances.* for efficiency metrics, the result from a DOE verification test must be greater than or equal to the certified rating × (1 − the applicable tolerance).

Equipment	Metric	Applicable tolerance
Refrigeration systems (including components)	AWEF	5%

(vii) *Invalid rating.* If, following discussions with the manufacturer and a retest where applicable, DOE determines that the testing was conducted appropriately in accordance with the DOE test procedure, the rating for the model will be considered invalid. Pursuant to 10 CFR 429.13(b), DOE may require a manufacturer to conduct additional testing as a remedial measure.

(g) *Alternative determination of ratings for untested basic models of residential water heaters and residential-duty commercial water heaters.* For models of water heaters that differ only in fuel type or power input, ratings for untested basic models may be established in accordance with the following procedures in lieu of testing. This method allows only for the use of ratings identical to those of a tested basic model as provided below; simulations or other modeling predictions for ratings of the uniform energy factor, volume, first-hour rating, or maximum gallons per minute (GPM) are not permitted.

(1) *Gas Water Heaters.* For untested basic models of gas-fired water heaters that differ from tested basic models only in whether the basic models use natural gas or propane gas, the represented value of uniform energy factor, first-hour rating, and maximum gallons per minute for an untested basic model is the same as that for a tested basic model, as long as the input ratings of the tested and untested basic models are within ±10%, that is:

$$\frac{|\textit{input rating of untested basic model} - \textit{input rating of tested basic model}|}{\textit{input rating of tested basic model}} \leq 10\%.$$

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(2) *Electric Storage Water Heaters.* Rate an untested basic model of an electric storage type water heater using the first-hour rating and the uniform energy factor obtained from a tested basic model as a basis for ratings of basic models with other input ratings, provided that certain conditions are met:

(i) For an untested basic model, the represented value of the first-hour rating and the uniform energy factor is the same as that of a tested basic model, provided that each heating element of the untested basic model is rated at or above the input rating for the corresponding heating element of the tested basic model.

(ii) For an untested basic model having any heating element with an input rating that is lower than that of the corresponding heating element in the tested basic model, the represented value of the first-hour rating and the uniform energy factor is the same as that of a tested basic model, provided that the first-hour rating for the untested basic model results in the same draw pattern specified in Table I of appendix E for the simulated-use test as was applied to the tested basic model. To establish whether this condition is met, determine the first-hour ratings for the tested and the untested basic models in accordance with the procedure described in section 5.3.3 of 10 CFR part 430, subpart B, appendix E, then compare the appropriate draw pattern specified in Table I of appendix E for the first-hour rating of the tested basic model with that for the untested basic model. If this condition is not met, then the untested basic model must be tested and the appropriate sampling provisions applied to determine its uniform energy factor in accordance with appendix E and this part.

(h) *Alternative efficiency determination method (AEDM) for compressors*—(1) *Criteria an AEDM must satisfy.*A manufacturer may not apply an AEDM to a basic model to determine its efficiency pursuant to this section, unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the basic model as measured by the applicable DOE test procedure;

(ii) The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data; and

(iii) The manufacturer has validated the AEDM, in accordance with paragraph (h)(2) of this section.

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability as follows:

(i) *AEDM overview.* The manufacturer must select at least the minimum number of basic models for each validation class specified in paragraph (h)(2)(iv) of this section to which the particular AEDM applies. Using the AEDM, calculate the energy use or energy efficiency for each of the selected basic models. Test each basic model and determine the represented value(s) in accordance with §429.63(a). Compare the results from the testing and the AEDM output according to paragraph (h)(2)(ii) of this section. The manufacturer is responsible for ensuring the accuracy and repeatability of the AEDM.

(ii) *AEDM basic model tolerances.* (A) The predicted representative values for each basic model calculated by applying the AEDM may not be more than five percent greater (for measures of efficiency) or less (for measures of consumption) than the represented values determined from the corresponding test of the model.

(B) The predicted package isentropic efficiency for each basic model calculated by applying the AEDM must meet or exceed the applicable federal energy conservation standard.

(iii) *Additional test unit requirements.* (A) Each AEDM must be supported by test data obtained from physical tests of current models; and

(B) Test results used to validate the AEDM must meet or exceed current, applicable Federal standards as specified in part 431 of this chapter; and

(C) Each test must have been performed in accordance with the applicable DOE test procedure with which compliance is required at the time the basic models used for validation are distributed in commerce.

(iv) *Compressor validation classes.*

Validation class	Minimum number of distinct basic models that must be tested
Rotary, Fixed-speed	2 Basic Models.
Rotary, Variable-speed	2 Basic Models.

(3) *AEDM Records Retention Requirements.* If a manufacturer has used an AEDM to determine representative values pursuant to this section, the manufacturer must have available upon request for inspection by the Department records showing:

(i) The AEDM, including the mathematical model, the engineering or statistical analysis, and/or computer simulation or modeling that is the basis of the AEDM;

(ii) Equipment information, complete test data, AEDM calculations, and the statistical comparisons from the units tested that were used to validate the AEDM pursuant to paragraph (h)(2) of this section; and

(iii) Equipment information and AEDM calculations for each basic model to which the AEDM was applied.

(4) *Additional AEDM requirements.* If requested by the Department, the manufacturer must:

(i) Conduct simulations before representatives of the Department to predict the performance of particular basic models of the equipment to which the AEDM was applied;

(ii) Provide analyses of previous simulations conducted by the manufacturer; and/or

(iii) Conduct certification testing of basic models selected by the Department.

[76 FR 12451, Mar. 7, 2011; 76 FR 24780, May 2, 2011, as amended at 78 FR 79595, Dec. 31, 2013; 79 FR 25505, May 5, 2014; 79 FR 27410, May 13, 2014; 80 FR 152, Jan. 5, 2015; 79 FR 40565, July 11, 2014; 81 FR 4145, Jan. 25, 2016; 81 FR 37054, June 8, 2016; 81 FR 89304, Dec. 9, 2016; 82 FR 1100, Jan. 4, 2017; 82 FR 1475, Jan. 5, 2017]

Title 10: Energy
PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT
Subpart T—Compressors

APPENDIX A TO SUBPART T OF PART 431—UNIFORM TEST METHOD FOR CERTAIN AIR COMPRESSORS

NOTE: Starting on July 3, 2017, any representations made with respect to the energy use or efficiency of compressors subject to testing pursuant to 10 CFR 431.344 must be made in accordance with the results of testing pursuant to this appendix.

I. MEASUREMENTS, TEST CONDITIONS, AND EQUIPMENT CONFIGURATION

A. Measurement Equipment

A.1. For the purposes of measuring air compressor performance, the equipment necessary to measure volume flow rate, inlet and discharge pressure, temperature, condensate, and packaged compressor power input must comply with the equipment and accuracy requirements specified in ISO 1217:2009(E) sections 5.2, 5.3, 5.4, 5.6, 5.9, and Annex C, sections C.2.3 and C.2.4 (incorporated by reference, see §431.343).

A.2. Electrical measurement equipment must be capable of measuring true root mean square (RMS) current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency.

A.3. Any instruments used to measure a particular parameter specified in paragraph (A.1.) must have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the square root of the sum of the squares of individual instrument accuracies.

A.4. Any instruments used to directly measure the density of air must have an accuracy of ±1.0 percent of the measured value.

A.5. Any pressure measurement equipment used in a calculation of another variable (*e.g.,* actual volume flow rate) must also meet all accuracy and measurement requirements of section 5.2 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

A.6. Any temperature measurement equipment used in a calculation of another variable (*e.g.,* actual volume flow rate) must also meet all accuracy and measurement requirements of section 5.3 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

A.7. Where ISO 1217:2009(E) refers to "corrected volume flow rate," the term is deemed synonymous with the term "actual volume flow rate," as defined in section 3.4.1 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

B. Test Conditions and Configuration of Unit Under Test

B.1. For both fixed-speed and variable-speed compressors, conduct testing in accordance with the test conditions, unit configuration, and specifications of ISO 1217:2009(E), Section 6.2 paragraphs (g) and (h) and Annex C, sections C.1.1, C.2.2, C.2.3, C.2.4, C.4.1, C.4.2.1, C.4.2.3, and C.4.3.2 (incorporated by reference, see §431.343).

B.2. The power supply must:

(1) Maintain the voltage greater than or equal to 95 percent and less than or equal to 110 percent of the rated value of the motor,

(2) Maintain the frequency within ±5 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

B.3. Ambient Conditions. The ambient air temperature must be greater than or equal to 68 °F and less than or equal to 90 °F for the duration of testing. There are no ambient condition requirements for inlet pressure or relative humidity.

B.4. All equipment indicated in Table 1 of this appendix must be present and installed for all tests specified in this appendix. If the compressor is distributed in commerce without an item from Table 1 of this appendix, the manufacturer must provide an appropriate item to be installed for the test. Additional ancillary equipment may be installed for the test, if distributed in commerce with the compressor, but this additional ancillary equipment is not required. If any of the equipment listed in Table 2 of this appendix is distributed in commerce with units of the compressor basic model, it must be present and installed for all tests specified in this appendix.

TABLE 1—EQUIPMENT REQUIRED DURING TEST

Equipment	Fixed-speed rotary air compressors	Variable-speed rotary air compressors
Driver	Yes	Yes.
Bare compressors	Yes	Yes.
Inlet filter	Yes	Yes.
Inlet valve	Yes	Yes.
Minimum pressure check valve/backflow check valve	Yes	Yes.
Lubricant separator	Yes	Yes.
Air piping	Yes	Yes.
Lubricant piping	Yes	Yes.
Lubricant filter	Yes	Yes.
Lubricant cooler	Yes	Yes.
Thermostatic valve	Yes	Yes.
Electrical switchgear or frequency converter for the driver	Yes	Not applicable.[1]
Device to control the speed of the driver (e.g., variable speed drive)	Not applicable[2]	Yes.
Compressed air cooler(s)	Yes	Yes.
Pressure switch, pressure transducer, or similar pressure control device	Yes	Yes.
Moisture separator and drain	Yes	Yes.

[1]This category is not applicable to variable-speed rotary air compressors.

[2]This category is not applicable to fixed-speed rotary air compressors.

TABLE 2—EQUIPMENT REQUIRED DURING TEST, IF DISTRIBUTED IN COMMERCE WITH THE BASIC MODEL

Equipment	Fixed-speed rotary air compressors	Variable-speed rotary air compressors
Cooling fan(s) and motors	Yes	Yes.
Mechanical equipment	Yes	Yes.
Lubricant pump	Yes	Yes.
Interstage cooler	Yes	Yes.
Electronic or electrical controls and user interface	Yes	Yes.
All protective and safety devices	Yes	Yes.

B.5. The inlet of the compressor under test must be open to the atmosphere and take in ambient air for all tests specified in this appendix.

B.6. The compressor under test must be set up according to all manufacturer instructions for normal operation (*e.g.*, verify lubricant level, connect all loose electrical connections, close off bottom of unit to floor, cover forklift

holes).

B.7. The piping connected to the discharge orifice of the compressor must be of a diameter at least equal to that of the compressor discharge orifice to which it is connected. The piping must be straight with a length of at least 6 inches.

B.8. Transducers used to record compressor discharge pressure must be located on the discharge piping between 2 inches and 6 inches, inclusive, from the discharge orifice of the compressor. The pressure tap for transducers must be located at the highest point of the pipe's cross section.

II. Determination of Package Isentropic Efficiency, Package Specific Power, and Pressure Ratio at Full-Load Operating Pressure

A. Data Collection and Analysis

A.1. Stabilization. Record data at each load point under steady-state conditions. Steady-state conditions are achieved when a set of two consecutive readings taken at least 10 seconds apart and no more than 60 seconds apart are within the maximum permissible fluctuation from the average (of the two consecutive readings), as specified in Table 1 of ISO 1217:2009(E) (incorporated by reference, see §431.343) for—

(1) Discharge pressure;

(2) Temperature at the nozzle or orifice plate, measured per section 5.3 of ISO 1217:2009(E) (incorporated by reference, see §431.343); and

(3) Differential pressure over the nozzle or orifice plate, measured per section 5.2 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

A.2. Data Sampling and Frequency. At each load point, record a minimum set of 16 unique readings, collected over a minimum time of 15 minutes. Each consecutive reading must be no more than 60 seconds apart, and not less than 10 seconds apart. All readings at each load point must be within the maximum permissible fluctuation from average specified in Table 1 of ISO 1217:2009(E) (incorporated by reference, see §431.343) for—

(1) Discharge pressure;

(2) Temperature at the nozzle or orifice plate, measured per section 5.3 of ISO 1217:2009(E) (incorporated by reference, see §431.343); and

(3) Differential pressure over the nozzle or orifice plate, measured per section 5.2 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

If one or more readings do not meet the requirements, then all previous readings must be disregarded and a new set of at least 16 new unique readings must be collected over a minimum time of 15 minutes. Average the readings to determine the value of each parameter to be used in subsequent calculations.

A.3. Calculations and Rounding. Perform all calculations using raw measured values. Round the final result for package isentropic efficiency to the thousandth (*i.e.,* 0.001), for package specific power in kilowatts per 100 cubic feet per minute to the nearest hundredth (*i.e.,* 0.01), for pressure ratio at full-load operating pressure to the nearest tenth (*i.e.,* 0.1), for full-load actual volume flow rate in cubic feet per minute to the nearest tenth (*i.e.,*0.1), and for full-load operating pressure in pounds per square inch gauge (psig) to the nearest integer (*i.e.,* 1). All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the tested unit.

B. Full-Load Operating Pressure and Full-Load Actual Volume Flow Rate

Determine the full-load operating pressure and full-load actual volume flow rate (referenced throughout this appendix) in accordance with the procedures prescribed in section III of this appendix.

C. Full-Load Package Isentropic Efficiency for Fixed- and Variable-Speed Air Compressors

Use this test method to test fixed-speed air compressors and variable-speed air compressors.

C.1. Test unit at full-load operating pressure and full-load volume flow rate according to the requirements established in sections I, II.A, and II.B of this appendix. Measure volume flow rate and calculate actual volume flow

rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343) with no corrections made for shaft speed. Measure discharge gauge pressure and packaged compressor power input. Measured discharge gauge pressure and calculated actual volume flow rate must be within the deviation limits for discharge pressure and volume flow rate specified in Tables C.1 and C.2 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343), where full-load operating pressure and full-load actual volume flow rate (as determined in section III of this appendix) are the targeted values.

C.2. Calculate the package isentropic efficiency at full-load operating pressure and full-load actual volume flow rate (full-load package isentropic efficiency, $\eta_{isen,FL}$) using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For P_{isen}, use the isentropic power required for compression at full-load operating pressure and full-load actual volume flow rate, as determined in section II.C.2.1 of this appendix. For P_{real}, use the real packaged compressor power input at full-load operating pressure and full-load actual volume flow rate, as determined in section II.C.2.2 of this appendix.

C.2.1. Calculate the isentropic power required for compression at full-load operating pressure and full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For q_{V1}, use the actual volume flow rate (cubic meters per second) calculated in section II.C.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) the measured discharge gauge pressure (Pa) from section II.C.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

C.2.2. Calculate real packaged compressor power input at full-load operating pressure and full-load actual volume flow rate using the following equation:

$$P_{real,100\%} = K_5 \cdot P_{PR,100\%}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see §431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,100\%}$ = packaged compressor power input reading at full-load operating pressure and full-load actual volume flow rate measured in section II.C.1 of this appendix (W).

D. Part-Load Package Isentropic Efficiency for Variable-Speed Air Compressors

Use this test method to test variable-speed air compressors.

D.1. Test unit at two load points: (1) Full-load operating pressure and 70 percent of full-load actual volume flow rate and (2) full-load operating pressure and 40 percent of full-load actual volume flow rate, according to the requirements established in sections I, II.A, and II.B of this appendix. To reach each specified load point, adjust the speed of the driver and the backpressure of the system. For each load point, measure volume flow rate and calculate actual volume flow rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343), with no corrections made for shaft speed. For each load point, measure discharge gauge pressure and packaged compressor power input. Measured discharge gauge pressure and calculated actual volume flow rate must be within the deviation limits for discharge pressure and volume flow rate specified in Tables C.1 and C.2 of Annex C of ISO 1217:2009(E), where the targeted values are as specified in the beginning of this section.

D.2. For variable-speed compressors, calculate the part-load package isentropic efficiency using the following equation:

$$\eta_{isen,PL} = \omega_{40\%} \times \eta_{isen,40\%} + \omega_{70\%} \times \eta_{isen,70\%} + \omega_{100\%} \times \eta_{isen,100\%}$$

Where:

$\eta_{isen,PL}$ = part-load package isentropic efficiency for a variable-speed compressor;

$\eta_{isen,100\%}$ = package isentropic efficiency at full-load operating pressure and 100 percent of full-load actual volume flow rate, as determined in section II.C.2 of this appendix;

$\eta_{isen,70\%}$ = package isentropic efficiency at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3 of this appendix;

$\eta_{isen,40\%}$ = package isentropic efficiency at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4 of this appendix;

$\omega_{40\%}$ = weighting at 40 percent of full-load actual volume flow rate and is 0.25;

$\omega_{70\%}$ = weighting at 70 percent of full-load actual volume flow rate and is 0.50; and

$\omega_{100\%}$ = weighting at 100 percent of full-load actual volume flow rate and is 0.25.

D.3. Calculate package isentropic efficiency at full-load operating pressure and 70 percent of full-load actual volume flow rate using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For P_{isen}, use the isentropic power required for compression at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3.1 of this appendix. For P_{real}, use the real packaged compressor power input at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3.2 of this appendix.

D.3.1. Calculate the isentropic power required for compression at full-load operating pressure and 70 percent of full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For q_{V1}, use actual volume flow rate (cubic meters per second) at full-load operating pressure and 70 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) discharge gauge pressure (Pa) at full-load operating pressure and 70 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

D.3.2. Calculate real packaged compressor power input at full-load operating pressure and 70 percent of full-load actual volume flow rate using the following equation:

$$P_{real,70\%} = K_5 \cdot P_{PR,70\%}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see §431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,70\%}$ = packaged compressor power input reading at full-load operating pressure and 70 percent of full-load actual volume flow rate, as measured in section II.D.1 of this appendix (W).

D.4. Calculate package isentropic efficiency at full-load operating pressure and 40 percent of full-load actual volume flow rate using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For P_{isen}, use the isentropic power required for compression at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4.1 of this appendix. For P_{real}, use the real packaged compressor power input at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4.2 of this appendix.

D.4.1. Calculate the isentropic power required for compression at full-load operating pressure and 40 percent of full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see §431.343). For q_{V1}, use actual volume flow rate (cubic meters per second) at full-load operating pressure and 40 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) discharge gauge pressure (Pa) at full-load operating pressure and 40 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

D.4.2. Calculate real packaged compressor power input at full-load operating pressure and 40 percent of full-load actual volume flow rate using the following equation:

$$P_{real,40\%} = K_5 \cdot P_{PR,40\%}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see §431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,40\%}$ = packaged compressor power input reading at full-load operating pressure and 40 percent of full-load actual volume flow rate, as measured in section II.D.1 of this appendix (W).

E. Determination of Package Specific Power

For both fixed and variable-speed air compressors, determine the package specific power, at any load point, using the equation for specific energy consumption in section C.4.4 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343) and other values measured pursuant to this appendix, with no correction for shaft speed. Calculate P_{Pcorr} in section C.4.4 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343) using the following equation:

$$P_{Pcorr} = K_5 \cdot P_{PR}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see §431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

P_{PR} = packaged compressor power input reading (W), as determined in section C.2.4 of Annex C to ISO 1217:2009(E) (incorporated by reference, see §431.343).

F. Determination of Pressure Ratio at Full-Load Operating Pressure

Pressure ratio at full-load operating pressure, as defined in §431.342, is calculated using the following equation:

$$LCL = \bar{x} - t_{0.95}\left(\frac{s}{\sqrt{n}}\right)$$

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Where:

PR = pressure ratio at full-load operating pressure;

p_1 = 100 kPa; and

p_{FL} = full-load operating pressure, determined in section III.C.4 of this appendix (Pa gauge).

III. Method to Determine Maximum Full-Flow Operating Pressure, Full-Load Operating Pressure, and Full-Load Actual Volume Flow Rate

A. Principal Strategy

The principal strategy of this method is to incrementally increase discharge pressure by 2 psig relative to a starting point, and identify the maximum full-flow operating pressure at which the compressor is capable of operating. The maximum discharge pressure achieved is the maximum full-flow operating pressure. The full-load operating pressure and full-load actual volume flow rate are determined based on the maximum full-flow operating pressure.

B. Pre-test Instructions

B.1. Safety

For the method presented in section III.C.1 of this appendix, only test discharge pressure within the safe operating range of the compressor, as specified by the manufacturer in the installation and operation manual shipped with the unit. Make no changes to safety limits or equipment. Do not violate any manufacturer-provided motor operational guidelines for normal use, including any restriction on instantaneous and continuous input power draw and output shaft power (*e.g.,* electrical rating and service factor limits).

B.2. Adjustment of Discharge Pressure

B.2.1. If the air compressor is not equipped, as distributed in commerce by the manufacturer, with any mechanism to adjust the maximum discharge pressure output limit, proceed to section III.B.3 of this appendix.

B.2.2. If the air compressor is equipped, as distributed in commerce by the manufacturer, with any mechanism to adjust the maximum discharge pressure output limit, then adjust this mechanism to the maximum pressure allowed, according to the manufacturer's operating instructions for these mechanisms. Mechanisms to adjust discharge pressure may include, but are not limited to, onboard digital or analog controls, and user-adjustable inlet valves.

B.3. Driver speed

If the unit under test is a variable-speed compressor, maintain maximum driver speed throughout the test. If the unit under test is a fixed-speed compressor with a multi-speed driver, maintain driver speed at the maximum speed throughout the test.

B.4. Measurements and Tolerances

B.4.1. Recording

Record data by electronic means such that the requirements of section B.4.5 of section III of this appendix are met.

B.4.2. Discharge Pressure

Measure discharge pressure in accordance with section 5.2 of ISO 1217:2009(E) (incorporated by reference, see §431.343). Express compressor discharge pressure in psig in reference to ambient conditions, and record it to the nearest integer. Specify targeted discharge pressure points in integer values only. The maximum allowable measured deviation from the targeted discharge pressure at each tested point is ±1 psig.

B.4.3. Actual Volume Flow Rate

Measure actual volume flow rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see §431.343) (where it is called "corrected volume flow rate") with no corrections made for shaft speed. Express compressor actual volume flow rate in cubic feet per minute at inlet conditions (cfm).

B.4.4. Stabilization

Record data at each tested load point under steady-state conditions, as determined in section II.A.1 of this appendix.

B.4.5. Data Sampling and Frequency

At each load point, record a set of at least of two readings, collected at a minimum of 10 seconds apart. All readings at each load point must be within the maximum permissible fluctuation from the average (of the two consecutive readings), as specified in II.A.2 of this appendix. Average the measurements to determine the value of each parameter to be used in subsequent calculations.

B.5. Adjusting System Backpressure

Set up the unit under test so that backpressure on the unit can be adjusted (*e.g.,* by valves) incrementally, causing the measured discharge pressure to change, until the compressor is in an unloaded condition.

B.6. Unloaded Condition

A unit is considered to be in an unloaded condition if capacity controls on the unit automatically reduce the actual volume flow rate from the compressor (*e.g.,* shutting the motor off, or unloading by adjusting valves).

C. Test Instructions

C.1. Adjust the backpressure of the system so the measured discharge pressure is 90 percent of the expected maximum full-flow operating pressure, rounded to the nearest integer, in psig. If the expected maximum full-flow operating pressure is not known, then adjust the backpressure of the system so that the measured discharge

pressure is 65 psig. Allow the unit to remain at this setting for 15 minutes to allow the unit to thermally stabilize. Then measure and record discharge pressure and actual volume flow rate at the starting pressure.

C.2. Adjust the backpressure of the system to increase the discharge pressure by 2 psig from the previous value, allow the unit to remain at this setting for a minimum of 2 minutes, and proceed to section III.C.3 of this appendix.

C.3. If the unit is now in an unloaded condition, end the test and proceed to section III.C.4 of this appendix. If the unit is not in an unloaded condition, measure discharge pressure and actual volume flow rate, and repeat section III.C.2 of this appendix.

C.4. Of the discharge pressures recorded under stabilized conditions in sections III.C.1 through III.C.3 of this appendix, identify the largest. This is the maximum full-flow operating pressure. Determine the full-load operating pressure as a self-declared value greater than or equal to the lesser of (A) 90 percent of the maximum full-flow operating pressure, or (B) 10 psig less than the maximum full-flow operating pressure.

C.5. The full-load actual volume flow rate is the actual volume flow rate measured at the full-load operating pressure. If the self-declared full-load operating pressure falls on a previously tested value of discharge pressure, then use the previously measured actual volume flow rate as the full-load actual volume flow rate. If the self-declared full-load operating pressure does not fall on a previously tested value of discharge pressure, then adjust the backpressure of the system to the self-declared full-load operating pressure and allow the unit to remain at this setting for a minimum of 2 minutes. The measured actual volume flow rate at this setting is the full-load actual volume flow rate.

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