
2. **Test conditions.** Establish the test conditions specified in section 2.9 of ANSI Z21.56–1994.

3. **Measurements.** Measure the quantities delineated in section 2.9 of ANSI Z21.56–1994. The measurement of energy consumption for oil-fired pool heaters in Btu is to be carried out in appropriate units, e.g., gallons.

4. **Calculations**

   4.1 **Thermal efficiency.** Calculate the thermal efficiency, \( E \) (expressed as a percent), as specified in section 2.9 of ANSI Z21.56–1994. The expression of fuel consumption for oil-fired pool heaters shall be in Btu.

   4.2 **Average annual fossil fuel energy for pool heaters.** The average annual fuel energy for pool heater, \( E_{\text{f}} \), is defined as:

   \[
   E_{\text{f}} = \text{BOH} \cdot \text{Q}_{\text{E}}
   \]

   where:

   \( \text{BOH} \) = average number of burner operating hours = 104 h

   \( \text{Q}_{\text{E}} \) = energy consumption of continuously operating pilot light:

   \[
   \text{Q}_{\text{E}} = \frac{\text{PE}}{100} \times \text{Q}_{\text{F}}
   \]

   \( \text{PE} \) = as defined in 4.4.1 of this appendix

   \( \text{Q}_{\text{F}} \) = thermal efficiency as defined in 4.1 of this appendix

4.4.1 Calculate the seasonal useful output of the pool heater as:

\[
\text{EFFY}_{\text{HS}} = 100 \times \frac{\text{E}_{\text{out}}}{\text{E}_{\text{in}}}
\]

where:

\( \text{E}_{\text{in}} \) = as defined in 4.4.1.1 of this appendix

\( \text{E}_{\text{out}} \) = as defined in 4.4.2 of this appendix

100 = conversion factor, from percent to fraction

4.4.2 Calculate the seasonal input to the pool heater as:

\[
\text{EFFY}_{\text{HC}} = 100 \times \frac{\text{E}_{\text{out}}}{\text{E}_{\text{in}}}
\]

where:

\( \text{E}_{\text{in}} \) = as defined in 4.4.1.1 of this appendix

\( \text{E}_{\text{out}} \) = as defined in 4.4.2 of this appendix

100 = to convert a fraction to percent

4.4.3 For pool heaters employing a continuous pilot light:

\[
\text{EFFY}_{\text{R}} = \frac{\text{E}_{\text{out}}}{\text{E}_{\text{in}}}
\]

where:

\( \text{E}_{\text{out}} \) = as defined in 4.4.1.1 of this appendix

\( \text{E}_{\text{in}} \) = as defined in 4.4.2 of this appendix

100 = to convert a fraction to percent

APPENDIX Q TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF FLUORESCENT LAMP BALLASTS

1. **Definitions**

   1.1 **AC control signal** means an alternating current (AC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

   1.2 **ANSI Standard** means a standard developed by a committee accredited by the American National Standards Institute.

   1.3 **Ballast input voltage** means the rated input voltage of a fluorescent lamp ballast.

   1.4 **DC control signal** means a direct current (DC) signal that is supplied to the ballast using additional wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

   1.5 **F4OT12 lamp** means a nominal 40 watt tubular fluorescent lamp which is 48 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81–2003 (Data Department of Energy
§ 430.3). Any subsequent amendment to this standard by the standard-setting organization will not affect the DOE test procedures unless and until amended by DOE. The test conditions are described in sections 4, 5, 6, 7, and 21 of ANSI C82.2-1984. The test conditions described in this section (2.1) are applicable to sections 3.3 and 3.4 of section 3, Test Method and Measurements.

2. Test Conditions

2.1 Measurement of Electric Supply and Light Output. The test conditions for testing fluorescent lamp ballasts shall be done in accordance with the ANSI C82.2-1984, (incorporated by reference; see § 430.3). Any subsequent amendment to this standard by the standard-setting organization will not affect the DOE test procedures unless and until amended by DOE. The test conditions are described in sections 4, 5, 6, 7, and 21 of ANSI C82.2-1984. The test conditions described in this section (2.1) are applicable to sections 3.3 and 3.4 of section 3, Test Method and Measurements.

2.2 Measurement of Standby Mode Power. The measurement of standby mode power need not be performed to determine compliance with energy conservation standards for fluorescent lamp ballasts at this time. The above statement will be removed as part of the rulemaking to amend the energy conservation standards for fluorescent lamp ballasts to account for standby mode energy consumption, and the following shall apply on the compliance date for such requirements.

The test conditions for testing fluorescent lamp ballasts shall be done in accordance with the American National Standard Institute (ANSI) C82.2-2002 (incorporated by reference; see § 430.3). Any subsequent amendment to this standard by the standard-setting organization will not affect the DOE test procedures unless and until amended by DOE. The test conditions for measuring standby power are described in sections 5, 7, and 8 of ANSI C82.2-2002. The test conditions described in this section (2.2) are applicable...
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3. TEST METHOD AND MEASUREMENTS

3.1 The test method for testing fluorescent lamp ballasts shall be done in accordance with ANSI C82.2–1984 (incorporated by reference; see §430.3). The test for measuring standby mode energy consumption of fluorescent lamp ballasts shall be done in accordance with ANSI C82.2–2002 (incorporated by reference; see §430.3).

3.2 Instrumentation. The instrumentation shall be as specified by sections 8, 9, 10, 11, 12, 19.1, and 23.2 of ANSI C82.2–1984 (incorporated by reference; see §430.3).

3.3 Electric Supply.

3.3.1 Input Power. Measure the input power (watts) to the ballast in accordance with ANSI C82.2–1984, section 3.2.1(3) and section 4 (incorporated by reference; see §430.3).

3.3.2 Input Voltage. Measure the input voltage (volts) (RMS) to the ballast in accordance with ANSI C82.2–1984, section 3.2.1(1) and section 4 (incorporated by reference; see §430.3).

3.4 Light Output.

3.4.1 Measure the light output of the reference lamp with the reference ballast in accordance with ANSI C82.2–1984, section 16 (incorporated by reference; see §430.3).

3.4.2 Measure the light output of the reference lamp with the test ballast in accordance with ANSI C82.2–1984, section 16 (incorporated by reference; see §430.3).

3.5 Standby Mode Power Measurement

3.5.1 Send a signal to the ballast instructing it to have zero light output using the appropriate ballast communication protocol or system for the ballast being tested.

3.5.2 Input Power. Measure the input power (watts) to the ballast in accordance with ANSI C82.2–2002, section 13, (incorporated by reference; see §430.3).

3.5.3 Control Signal Power. The power from the control signal path will be measured using all applicable methods described below.

3.5.3.1 AC Control Signal. Measure the AC control signal power (watts), using a wattmeter (W), connected to the ballast in accordance with the circuit shown in Figure 1.

3.5.3.2 DC Control Signal. Measure the DC control signal voltage, using a voltmeter (V), and current, using an ammeter (A), connected to the ballast in accordance with the circuit shown in Figure 2. The DC control signal power is calculated by multiplying the DC control signal voltage and the DC control signal current.

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**Figure 1: Circuit for Measuring AC Control Signal Power in Standby Mode**

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**Figure 2: Circuit for Measuring DC Control Signal Power in Standby Mode**
3.5.3.3 Power Line Carrier (PLC) Control Signal. Measure the PLC control signal power (watts), using a wattmeter (W), connected to the ballast in accordance with the circuit shown in Figure 3. The wattmeter must have a frequency response that is at least 10 times higher than the PLC being measured in order to measure the PLC signal correctly. The wattmeter must also be high-pass filtered to filter out power at 60 Hertz.

3.5.3.4 Wireless Control Signal. The power supplied to a ballast using a wireless signal is not easily measured, but is estimated to be well below 1.0 watt. Therefore, the wireless control signal power is not measured as part of this test procedure.


4.1 Calculate relative light output:

\[
\text{relative light output} = \frac{\text{photocell output of lamp on test ballast}}{\text{photocell output of lamp on ref. ballast}} \times 100
\]

Where:
photocell output of lamp on test ballast is determined in accordance with section 3.4.2, expressed in watts, and photocell output of lamp on ref. ballast is determined in accordance with section 3.4.1, expressed in watts.

4.2 Determine the Ballast Efficacy Factor (BEF) using the following equations:

(a) Single lamp ballast

\[
\text{BEF} = \frac{\text{relative light output}}{\text{input power}}
\]

(b) Multiple lamp ballast

\[
\text{BEF} = \frac{\text{average relative light output}}{\text{input power}}
\]

Where:
input power is determined in accordance with section 3.3.1,
relative light output as defined in section 4.1, and
average relative light output is the relative light output, as defined in section 4.1, for all lamps, divided by the total number of lamps.

4.3 Determine Ballast Power Factor (PF):
2.6 Lamp efficacy means the ratio of measured lamp electrical power input in watts, rounded to the nearest tenth, in units of lumens per watt.

2.7 Lamp lumen output means the total luminescent flux produced by the lamp, at the reference condition, in units of lumens.

2.8 Lamp electrical power input means the total electrical power input to the lamp, including both arc and cathode power where appropriate, at the reference condition, in units of watts.

2.9 Reference condition means the test condition specified in IESNA LM-9 for general service fluorescent lamps, in IESNA LM-20 for incandescent reflector lamps, in IESNA LM-45 for general service incandescent lamps (incorporated by reference; see §430.3).

3. Test Conditions

3.1 General Service Fluorescent Lamps: For general service fluorescent lamps, the ambient conditions of the test and the electrical circuits, reference ballasts, stabilization requirements, instruments, detectors, and photometric test procedure and test report shall be as described in the relevant sections of IESNA LM-9 (incorporated by reference; see §430.3).

3.2 General Service Incandescent Lamps: For general service incandescent lamps, the selection and seasoning (initial burn-in) of the test lamps, the equipment and instrumentation, and the test conditions shall be as described in IESNA LM-45 (incorporated by reference; see §430.3).

3.3 Incandescent Reflector Lamps: For incandescent reflector lamps, the selection and seasoning (initial burn-in) of the test lamps, the equipment and instrumentation, and the test conditions shall conform to sections 4.2 and 5.0 of IESNA LM-20 (incorporated by reference; see §430.3).

4. Test Methods and Measurements

All lumen measurements made with instruments calibrated to the devalued NIST lumen after January 1, 1996, shall be multiplied by 1.011.

4.1 General Service Fluorescent Lamps

4.1.1 The measurement procedure shall be as described in IESNA LM-9 (incorporated by reference; see §430.3), except that lamps shall be operated at the appropriate voltage and current conditions as described in ANSI C78.375 (incorporated by reference; see §430.3) and in ANSI C78.81 (incorporated by reference; see §430.3) or ANSI C78.901 (incorporated by reference; see §430.3), and lamps shall be operated using the appropriate reference ballast at input voltage specified by the reference circuit as described in ANSI C62.3 (incorporated by reference; see §430.5). If, for a lamp, both low-frequency and high-frequency reference ballast settings are included in ANSI C78.81 or ANSI C78.901, the lamp shall be operated using the low-frequency reference ballast.

4.1.2 For lamps not listed in ANSI C78.81 (incorporated by reference; see §430.3) nor in ANSI C78.901 (incorporated by reference; see §430.3), the lamp shall be operated using the following reference ballast settings:

4.1.2.1 4-Foot medium bi-pin lamps shall be operated using the following reference ballast settings: T10 or T12 lamps are to use