Appendix P to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Pool Heaters


4. Calculations

4.1 Thermal efficiency. Calculate the thermal efficiency, E\(_t\) (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\(_f\), is defined as:

\[
E_f = BOH Q_{\text{in}} + (POH - BOH) Q_{\text{out}}
\]

where:

- BOH = average number of burner operating hours = 104 h
- POH = average number of pool operating hours = 4464 h
- \(Q_{\text{in}}\) = rated fuel energy input as defined according to 2.9.1 or 2.9.2 of ANSI Z21.56–1994, as appropriate
- \(Q_{\text{out}}\) = energy consumption of continuously operating pilot light if employed, in Btu/h.

4.3 Average annual auxiliary electrical energy consumption for pool heaters. The average annual auxiliary electrical energy consumption for pool heaters, E\(_{AE}\), is expressed in Btu and defined as:

\[
E_{AE} = \text{BOH } PE
\]

where:

- PE = 2E\(_t\), if heater tested according to 2.9.1 of ANSI Z21.56–1994
- PE = 3.412 PE\(_{\text{rated}}\), if heater tested according to 2.9.2 of ANSI Z21.56–1994, in Btu/h

E\(_t\) = Electrical consumption of the heater (converted to equivalent unit of Btu), including the electrical energy to the circulating pump if used, during the 30-minute thermal efficiency test, as defined in 2.9.1 of ANSI Z21.56–1994, in Btu per 30 min.

4.4 Heating seasonal efficiency.

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

\[
E_{\text{OUT}} = \text{BOH} \left( \frac{E_t}{100} Q_{\text{in}} + PE \right)
\]

where:

- BOH = as defined in 4.2 of this appendix
- E\(_t\) = thermal efficiency as defined in 4.1 of this appendix
- \(Q_{\text{in}}\) = as defined in 4.2 of this appendix
In the pool heating season in which the pool heater is connected to the power source, and the main burner, electric resistance element, or heat pump is activated to heat pool water.


1.3 Off mode means the condition during the pool non-heating season in which the pool heater is connected to the power source, and neither the main burner, electric resistance elements, nor heat pump is activated.

1.4 Seasonal off switch means a switch present on the pool heater that effects a difference in off mode energy consumption as compared to standby mode energy consumption.

1.5 Standby mode means the condition during the pool heating season in which the pool heater is connected to the power source, and neither the main burner, electric resistance elements, nor heat pump is activated.

2. Test Method.

2.1 Active mode. The test method for testing pool heaters in active mode is as specified in section 2.10 of ANSI Z21.56 (incorporated by reference; see §430.3).

2.2 Standby mode. The test method for testing the energy consumption of pool heaters in standby mode is as described in sections 3 through 5 of this appendix.

2.3 Pool heaters with a seasonal off switch.

2.3.1 Pool heaters with a seasonal off switch. For pool heaters with a seasonal off switch, no off-mode test is required.

2.3.2 Pool heaters without a seasonal off switch.

For pool heaters without a seasonal off switch, the test method for testing the energy consumption of the pool heater is as described in sections 3 through 5 of this appendix.

3. Test conditions.

3.1 Active mode. Establish the test conditions specified in section 2.10 of ANSI Z21.56 (incorporated by reference; see §430.3).

3.2 Standby mode and off mode. Following the conclusion of the 30-minute active mode test described in section 2.10 of ANSI Z21.56 (incorporated by reference; see §430.3), reduce the thermostat setting to a low enough temperature to put the pool heater into standby mode. Operate the pool heater in standby mode for 60 minutes.


4.1 Active mode. Measure the quantities delineated in section 2.10 of ANSI Z21.56 (incorporated by reference; see §430.3). The measurement of energy consumption for oil-fired pool heaters in Btu is to be carried out in appropriate units (e.g., gallons).

4.2 Standby mode. Record the average electric power consumption during the standby mode test, \( P_{w,sn} \), in W, in accordance with
section 5 of IEC 62301 (Second Edition) (incorporated by reference; see § 430.3) and the fossil fuel energy consumption during the standby test, \(Q_{\text{ST}}\), in Btu. Ambient temperature and voltage specifications of ANSI Z21.56 (incorporated by reference; see § 430.3) shall apply to this standby mode testing. The recorded standby power \(P_{\text{SB}}\) shall be rounded to the second decimal place, and for loads greater than or equal to 10W, at least three significant figures shall be reported.

4.3 Off mode.

4.3.1 Pool heaters with a seasonal off switch. For pool heaters with a seasonal off switch, the average electric power consumption during the off mode, \(P_{\text{OFF}}\), and the fossil fuel energy consumed during the off mode, \(Q_{\text{OFF}}\), shall be recorded off mode power (\(P_{\text{OFF}}\)).

The recorded standby power \(P_{\text{SB}}\) shall be rounded to the second decimal place, and for loads greater than or equal to 10W, at least three significant figures shall be reported.

4.3.2 Pool heaters without a seasonal off switch. Record the average electric power consumption during the standby/off mode test, \(P_{\text{W,SB/OFF}}\) = \(\frac{P_{\text{W,SB}} + P_{\text{W,OFF}}}{2}\), in W, in accordance with section 5 of IEC 62301 (Second Edition) (incorporated by reference; see § 430.3), and the fossil fuel energy consumption during the off mode test, \(Q_{\text{OFF}}\) = \(\frac{Q_{\text{ON}} + Q_{\text{OFF}}}{2}\), in Btu. Ambient temperature and voltage specifications of ANSI Z21.56 (incorporated by reference; see § 430.3) shall apply to this off mode testing. The recorded off mode power \(P_{\text{W,OFF}}\) shall be rounded to the second decimal place, and for loads greater than or equal to 10W, at least three significant figures shall be reported.

5. Calculations.

5.1 Thermal efficiency. Calculate the thermal efficiency, \(E_{t}\) (expressed as a percent), as specified in section 2.10 of ANSI Z21.56 (incorporated by reference; see § 430.3). The expression of fuel consumption for oil-fired pool heaters shall be in Btu.

5.2 Average annual fossil fuel energy for pool heaters. The average annual fuel energy for pool heaters, \(E_{t}\), is defined as:

\[
E_{t} = \text{BOH} \frac{Q_{\text{IN}}}{100} + \left(\text{POH} - \text{BOH}\right)Q_{\text{OUT}} + (8760 - \text{POH})Q_{\text{OUT}}
\]

Where:
- \(\text{BOH}\) = average number of burner operating hours = 104 h
- \(\text{POH}\) = average number of pool operating hours = 4464 h
- \(Q_{\text{IN}}\) = rated fuel energy input as defined according to section 2.10.1 or section 2.10.2 of ANSI Z21.56, as appropriate.
- \(Q_{\text{OUT}}\) = average energy consumption rate of continuously operating pilot light, if employed, \(= (Q_{\text{OUT}}\) for 1 h).
- \(Q_{\text{OFF}}\) = energy consumption of continuously operating pilot light, if employed, as measured in section 4.2 of this appendix, in Btu
- \(8760\) = number of hours in one year
- \(Q_{\text{OFF(1h)}}\) = off mode fossil fuel energy consumption rate = \(Q_{\text{OFF}}/1\text{h}\)
- \(Q_{\text{OFF}}\) = off mode energy consumption as defined in section 4.3 of this appendix

5.3 Average annual auxiliary electrical energy consumption for pool heaters. The average annual auxiliary electrical energy consumption for pool heaters, \(E_{AE}\), is expressed in Btu and defined as:

1. \(E_{AE} = E_{AE,\text{active}} + E_{AE,\text{standby,off}}\)
2. \(E_{AE,\text{active}} = \text{BOH} \times PE\)
3. \(E_{AE,\text{standby,off}} = (\text{POH} - \text{BOH})P_{\text{W,SB/OFF}} + \left(8760 - \text{POH}\right)P_{\text{W,OFF}}\)

Where:
- \(E_{AE,\text{active}}\) = auxiliary electrical consumption in the active mode
- \(E_{AE,\text{standby,off}}\) = auxiliary electrical consumption in the standby mode and off mode
- \(PE\) = \(2E_{t}\), if heater is tested according to section 2.10.1 of ANSI Z21.56, in Btu/h = \(3.412\frac{100}{\text{PE}_{\text{OUT}}}\), if heater is tested according to section 2.10.2 of ANSI Z21.56, in Btu/h
- \(E_{t}\) = thermal efficiency as defined in 5.1 of this appendix
- \(E_{AE}\) = auxiliary electrical equipment of heater, in Watts
- \(\text{BOH}\) = as defined in 5.2 of this appendix
- \(\text{POH}\) = as defined in 5.2 of this appendix
- \(P_{\text{W,SB/OFF}}\) = electrical energy consumption rate during standby mode expressed in Btu/h = \(3.412P_{\text{W,SB/OFF}}\), Btu/h
- \(P_{\text{W,SB}}\) = as defined in 4.2 of this appendix
- \(P_{\text{W,OFF}}\) = electrical energy consumption rate during off mode expressed in Btu/h = \(3.412P_{\text{W,OFF}}\), Btu/h
- \(P_{\text{W,OFF}}\) = as defined in 4.3 of this appendix
- 2 = conversion factor to convert unit from per 30 min. to per h.
- \(PE_{\text{OUT}}\) = nameplate rating of auxiliary electrical equipment of heater, in Watts
- \(\text{BOH}\) = as defined in section 5.2 of this appendix
- \(\text{POH}\) = as defined in 5.3 of this appendix
- 100 = conversion factor, from percent to fraction

5.4 Integrated thermal efficiency.

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

\[
E_{\text{OUT}} = \text{BOH}(E_{t}100/(Q_{\text{IN}} + PE))
\]

Where:
- \(E_{t}\) = thermal efficiency as defined in 5.1 of this appendix
- \(\text{BOH}\) = as defined in 5.2 of this appendix
- \(\text{POH}\) = as defined in 5.3 of this appendix
- \(PE\) = as defined in 5.3 of this appendix
- \(100\) = conversion factor, from percent to fraction

5.4.2 Calculate the annual input to the pool heater as:

\[
E_{\text{IN}} = E_{t} + E_{AE}
\]

Where:
- \(E_{t}\) = as defined in 5.2 of this appendix
- \(E_{AE}\) = as defined in 5.3 of this appendix

5.4.3 Calculate the pool heater integrated thermal efficiency \(TE_{i}\) (in percent).

\[
TE_{i} = 100\frac{E_{\text{OUT}}}{E_{\text{IN}}}
\]

Where:
- \(E_{\text{OUT}}\) = as defined in 5.4.1 of this appendix
- \(E_{\text{IN}}\) = as defined in 5.4.2 of this appendix
Appendix Q to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Fluorescent Lamp Ballasts

Comply with Appendix Q until November 14, 2014. After this date, all fluorescent lamp ballasts shall be tested using the provisions of Appendix Q1.

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 F40T12 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 (Data Sheet 7881–ANSI–1006–1) (incorporated by reference; see § 430.3).

1.6 F96T12 lamp means a nominal 75 watt tubular fluorescent lamp which is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881–ANSI–3007–1) (incorporated by reference; see § 430.3).

1.7 F96T12HO lamp means a nominal 110 watt tubular fluorescent lamp which is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881–ANSI–1006–1) (incorporated by reference; see § 430.3).

1.8 F34T12 lamp (also known as a “F34T12/ES lamp”) means a nominal 34 watt tubular fluorescent lamp that is 48 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881–ANSI–1006–1) (incorporated by reference; see § 430.3).

1.9 F60T12/ES lamp means a nominal 60 watt tubular fluorescent lamp that is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881–ANSI–3006–1) (incorporated by reference; see § 430.3).

1.10 F96T12HO/ES lamp means a nominal 95 watt tubular fluorescent lamp that is 96 inches in length and one and a half inches in diameter, and conforms to ANSI C78.81 (Data Sheet 7881–ANSI–1006–1) (incorporated by reference; see § 430.3).

1.11 Input current means the root-mean-square (RMS) current in amperes delivered to a fluorescent lamp ballast.

1.12 Luminaire means a complete lighting unit consisting of a fluorescent lamp or lamps, together with parts designed to distribute the light, to position and protect such lamps, and to connect such lamps to the power supply through the ballast.

1.13 Nominal lamp watts means the wattage at which a fluorescent lamp is designed to operate.

1.14 PLC control signal means a power line carrier (PLC) signal that is supplied to the ballast using the input ballast wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

1.15 Power Factor means the power input divided by the product of ballast input voltage and input current of a fluorescent lamp ballast, as measured under test conditions specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.16 Power input means the power consumption in watts of a ballast a fluorescent lamp or lamps, as determined in accordance with the test procedures specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.17 Relative light output means the light output delivered through the use of a ballast divided by the light output of a reference ballast, expressed as a percent, as determined in accordance with the test procedures specified in ANSI C82.2 (incorporated by reference; see § 430.3).

1.18 Residential building means a structure or portion of a structure which provides facilities or shelter for human residency, except that such term does not include any multifamily residential structure of more than three stories above grade.

1.19 Standby mode means the condition in which an energy-using product—

(a) Is connected to a main power source; and

(b) Offers one or more of the following user-oriented or protective functions:

(i) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

(ii) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

1.20 Wireless control signal means a wireless signal that is radiated to and received by the ballast for the purpose of controlling the ballast and putting the ballast in standby mode.

2. Test Conditions.

2.1 Measurement of Active Mode Energy Consumption, BEF. The test conditions for testing fluorescent lamp ballasts shall be...