APPENDIX P TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF POOL HEATERS

1. Test method. The test method for testing pool heaters is as specified in American National Standards Institute Standard for Gas-Fired Pool Heaters, Z21.56–1994.

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_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:

$$E_F = BOH\ Q_{IN} + (POH - BOH)Q_P$$

where:

BOH=average number of burner operating hours=104 h
POH=average number of pool operating hours=4464 h
Q_{IN}=rated fuel energy input as defined according to 2.9.1 or 2.9.2 of ANSI Z21.56–1994, as appropriate
Q_P=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:

$$E_{AE} = BOH\ PE$$

where:

PE=$2E_c$ if heater tested according to 2.9.1 of ANSI Z21.56–1994
=3.412 PE_{rated} if heater tested according to 2.9.2 of ANSI Z21.56–1994, in Btu/h
E_c=Electrical consumption of the heater (converted to equivalent unit of Btu), including the electrical energy to the recirculating 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.
2=Conversion factor to convert unit from per 30 min. to per h.
PE_{rated}=nameplate rating of auxiliary electrical equipment of heater, in Watts
BOH=as defined in 4.2 of this appendix

4.4 *Heating seasonal efficiency.*

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

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

where:

BOH=as defined in 4.2 of this appendix
E_t=thermal efficiency as defined in 4.1 of this appendix
Q_{IN}=as defined in 4.2 of this appendix
PE=as defined in 4.3 of this appendix
100=conversion factor, from percent to fraction

4.4.2 Calculate the seasonal input to the pool heater as:

$$E_{IN} = BOH\ (Q_{IN} + PE) + (POH - BOH)\ Q_P$$

where:

BOH=as defined in 4.2 of this appendix
Q_{IN}=as defined in 4.2 of this appendix
PE=as defined in 4.3 of this appendix
POH=as defined in 4.2 of this appendix
Q_P=as defined in 4.2 of this appendix

4.4.3 *Calculate the pool heater heating seasonal efficiency (in percent).*

4.4.3.1 For pool heaters employing a continuous pilot light:

$$EFFY_{HS} = 100(E_{OUT}/E_{IN})$$

where:

E_{OUT}=as defined in 4.4.1 of this appendix
E_{IN}=as defined in 4.4.2 of this appendix
100=to convert a fraction to percent

4.4.3.2 For pool heaters without a continuous pilot light:

$$EFFY_{HS} = E_t$$

where:

E_t=as defined in 4.1 of this appendix.

[62 FR 26165, May 12, 1997]

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

Sheet 7881–ANSI–1010–1) (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 one-half inches in diameter, and conforms to ANSI C78.81–2003 (Data Sheet 7881–ANSI–3007–1) (incorporated by reference; *see* §430.3).

1.7 *F96T12HO lamp* means a nominal 110 watt tubular fluorescent lamp that is 96 inches in length and 1½ inches in diameter, and conforms to ANSI C78.81–2003 (Data Sheet 7881–ANSI–1019–1) (incorporated by reference; *see* §430.3).

1.8 *F34T12 lamp* (also known as a ''F40T12/ES lamp'') means a nominal 34 watt tubular fluorescent lamp that is 48 inches in length and 1½ inches in diameter, and conforms to ANSI C78.81–2003 (Data Sheet 7881–ANSI–1006–1) (incorporated by reference; *see* §430.3).

1.9 *F96T12/ES lamp* means a nominal 60 watt tubular fluorescent lamp that is 96 inches in length and 1½ inches in diameter, and conforms to ANSI C78.81–2003 (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 1½ inches in diameter, and conforms to ANSI C78.81–2003 (Data Sheet 7881–ANSI–1017–1) (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 C–82.2–1984 (incorporated by reference; *see* §430.3).

1.16 *Power input* means the power consumption in watts of a ballast and fluorescent lamp or lamps, as determined in accordance with the test procedures specified in ANSI C82.2–1984 (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 delivered through the use of a reference ballast, expressed as a percent, as determined in accordance with the test procedures specified in ANSI C82.2–1984 (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 stores 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 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

to section 3.5 of 3, Test Method and Measurements. Fluorescent lamp ballasts that are capable of connections to control devices shall be tested with all commercially available compatible control devices connected in all possible configurations. For each configuration, a separate measurement of standby power shall be made in accordance with section 3.5 of the test procedure.

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).

3.3.3 *Input Current.* Measure the input current (amps) (RMS) to the ballast in accordance with ANSI C82.2–1984, section 3.2.1(2) 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.

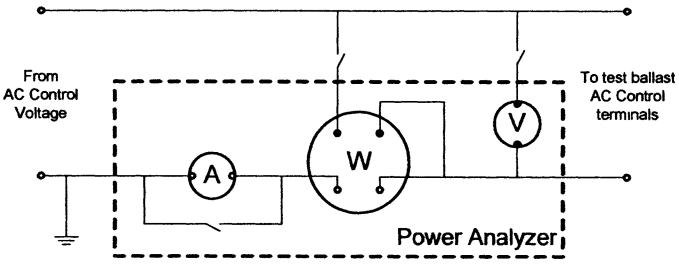

Figure 1: Circuit for Measuring AC Control Signal Power in Standby Mode

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.

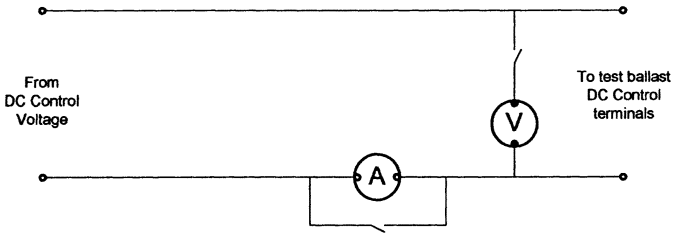

Figure 2: Circuit for Measuring DC Control Signal Power in Standby Mode

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.

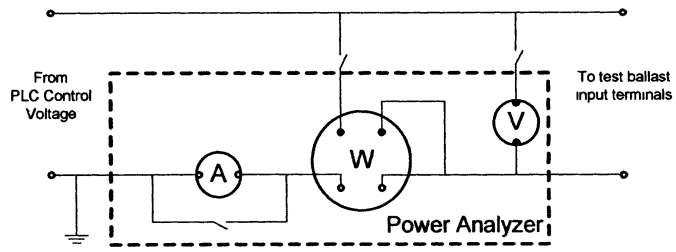

Figure 3: Circuit for Measuring PLC Control Signal Power in Standby Mode

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. Calculations.

4.1 Calculate relative light output:

$$\frac{\text{Photocell output of lamp on test ballast}}{\text{Photocell output of lamp on ref. ballast}} \times 100 = \text{relative light output}$$

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):

$$PF = \frac{\text{Input power}}{\text{Input voltage} \times \text{input current}}$$

Where:

Input power is as defined in section 3.3.1,

Input voltage is determined in accordance with section 3.3.2, expressed in volts, and

Input current is determined in accordance with section 3.3.3, expressed in amps.

[54 FR 6076, Feb. 7, 1989, as amended at 56 FR 18682, April 24, 1991; 69 FR 18803, Apr. 9, 2004; 70 FR 60412, Oct. 18, 2005; 74 FR 54455, Oct. 22, 2009]

APPENDIX R TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING AVERAGE LAMP EFFICACY (LE), COLOR RENDERING INDEX (CRI), AND CORRELATED COLOR TEMPERATURE (CCT) OF ELECTRIC LAMPS

1. *Scope:* This appendix applies to the measurement of lamp lumens, electrical characteristics, CRI, and CCT for general service fluorescent lamps, and to the measurement of lamp lumens, electrical characteristics for general service incandescent lamps and incandescent reflector lamps.

2. *Definitions*

2.1 To the extent that definitions in the referenced IESNA and CIE standards do not conflict with the DOE definitions, the definitions specified in section 1.2 of IESNA LM–9 (incorporated by reference; see §430.3), section 3.0 of IESNA LM–20 (incorporated by reference; see §430.3), section 1.2 and the Glossary of IESNA LM–45 (incorporated by reference; see §430.3), section 2 of IESNA LM–58 (incorporated by reference; see §430.3), and Appendix 1 of CIE 13.3 (incorporated by reference; see §430.3) shall be included.

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

2.3 *CIE* means the International Commission on Illumination.

2.4 *CRI* means Color Rendering Index as defined in §430.2.

2.5 *IESNA* means the Illuminating Engineering Society of North America.

2.6 *Lamp efficacy* means the ratio of measured lamp lumen output in lumens to the 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 luminous 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 C82.3 (incorporated by reference; see §430.3). 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