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ENERGY STAR® Reflector CFL Elevated Temperature Test Procedure

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1.0 Introduction

The test procedure described in this document is designed to facilitate the photometric and life testing of integrated compact fluorescent reflector lamps in an elevated temperature environment. The procedure is designed to simulate the environment that an integrated compact fluorescent reflector lamp will likely experience when installed in an airtight (ICAT) downlight in an insulated ceiling. Non-reflector compact fluorescent lamps and non-integrated compact fluorescent lamps are excluded from this test procedure.

2.0 Power Requirements

The power supply utilized in the testing shall be capable of providing the nominal rated input voltage and frequency for the lamp(s) under test. The input voltage of the power supply shall be regulated to within ±2 percent of the rated rms value. In addition to the preceding voltage regulation requirements, the power supply shall meet the criteria as detailed in IESNA LM-28[1] and IESNA LM-65-01[2].
Note: when selecting a power supply for use with integrated compact fluorescent reflector lamps, it is necessary to apply an appropriate power factor when specifying the Volt-Amp rating of the power supply. Many integrated compact fluorescent reflector lamps have a power factor in the range of 0.5 to 0.6.

3.0 Photometric Measurements

The photodetector used for photometric measurements shall be a silicon detector corrected to closely fit the CIE spectral luminous efficiency curve (V_λ)[3].

4.0 Temperature Measurements

Temperature measurements shall be acquired using a thermocouple junction and measuring instrument. It is recommended that a data-logging instrument be used or that an instrument capable of interface to a computer be used in conjunction with data-logging software. Thermocouples shall be chosen based on the range of temperatures that are likely to be experienced in the course of ambient temperature testing (typically between 25°C and 100°C). Specially designed ambient temperature probes are commonly available and may be used for ambient temperature measurements.

5.0 Sample Selection

Samples for Initial Elevated Temperature Light Output Testing and Elevated Temperature Testing shall be representative of the manufacturer's typical product. The samples shall be cleaned and thoroughly inspected before testing. Any flaws or inconsistencies in the lamp samples shall be noted.

6.0 Initial Elevated Temperature Light Output Measurement Apparatus

6.1 Test Environment

The test environment shall be clean and free from large amounts of dust and moisture. Care should be taken to minimize the amount of extraneous light and reflected light in the vicinity of the testing apparatus. This may be accomplished by the imposition of shields or baffles in appropriate locations within the testing facility. Additionally, the walls, flooring, and ceiling of the testing facility may be covered with a flat black paint or covering. The test apparatus should be located in a position free from excessive drafts such as may be caused by the opening of doors or windows, proximity to HVAC systems, or frequent through-traffic.

6.2 Construction of Apparatus

The initial elevated temperature light output measurement apparatus shall be constructed according to the specifications for the construction of a thermal test apparatus for IC-rated luminaires as described in UL 1598[4]. The thermal test apparatus shall be supported such that the aperture of the IC-rated luminiare is suspended 36" above the photodetector. The photodetector shall be positioned at nadir below the luminaire with its measuring surface perpendicular to the path of direct light from the luminaire. It is recommended that the photodetector be secured to a locating device that will allow precise and repeatable positioning of the photodetector.

6.2.1 Ambient Luminaire

The ambient luminaire should be constructed with as little enclosing material as is possible while still providing a rigid support for the lamp under test. It is recommended that the ambient luminaire be designed to allow the adjustment of the test lamp's vertical position within the aperture. This will allow both the centering of the test lamp as well as adjustment of the luminaire to accommodate a variety of different bulb shapes. See figure 1.

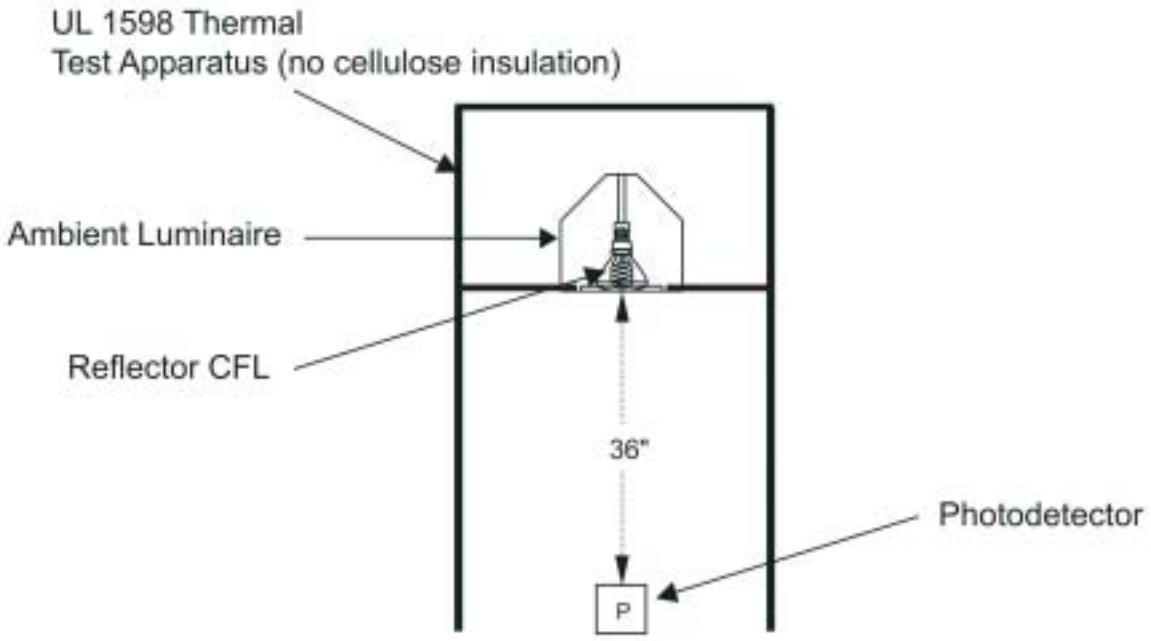

FIGURE 1: DESIGN OF THE INITIAL ELEVATED TEMPERATURE LIGHT OUTPUT MEASUREMENT APPARATUS (AMBIENT LUMINAIRE INSTALLED)

6.2.2 IC-rated Luminaire

The IC-rated luminaire shall be a nominal 6” aperture, 8” deep, airtight (ICAT) downlight. See figure 2. It is recommended that the luminaire be modified to ensure the positive vertical location of the lamp within the luminaire. This will allow the adjustment of the luminaire to accommodate a variety of different bulb shapes. The IC-rated luminaire shall then be installed in the UL 1598 thermal box (See figure 3).

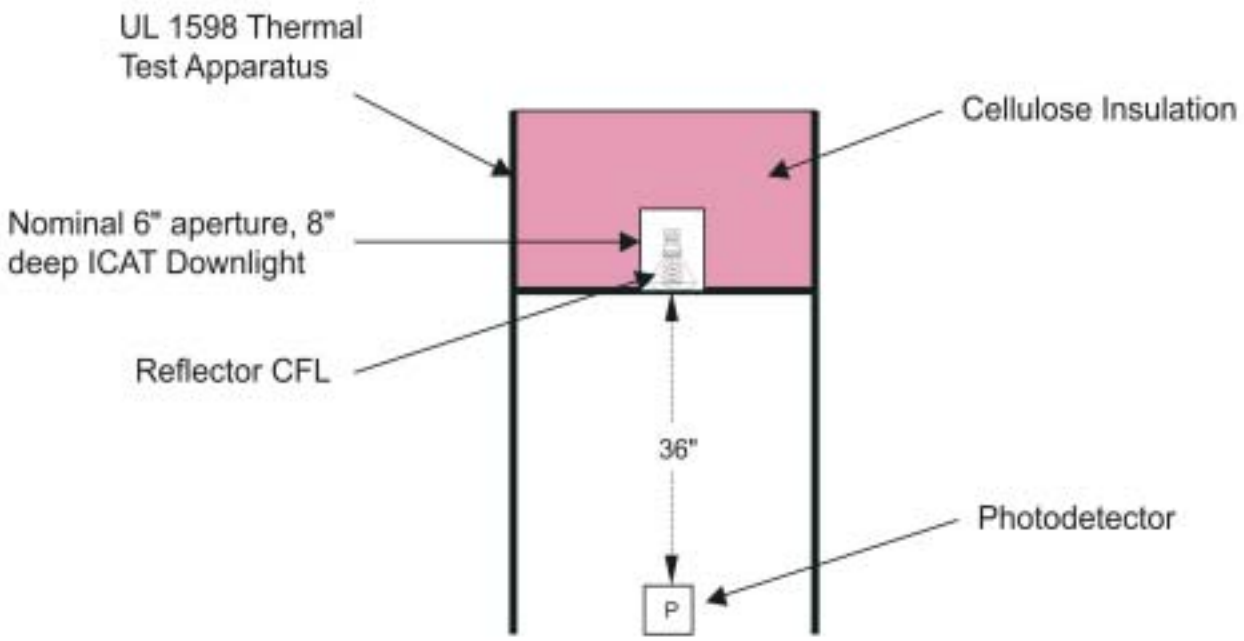

FIGURE 2: DESIGN OF THE INITIAL ELEVATED TEMPERATURE LIGHT OUTPUT MEASUREMENT APPARATUS (IC-RATED LUMINAIRE INSTALLED)

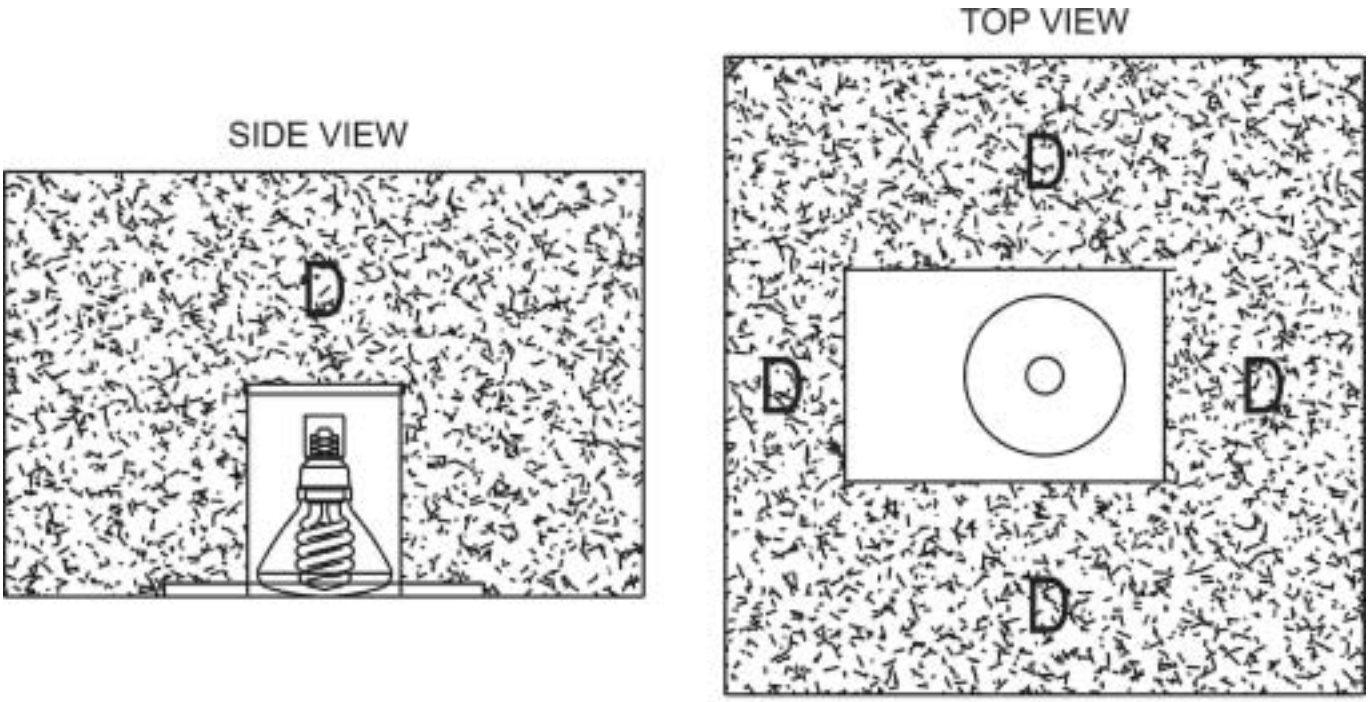

FIGURE 3: INSTALLATION OF THE IC-RATED LUMINAIRE.
"D" IS THE MINIMUM DIMENSION REQUIRED BY UL 1598

6.3 Temperature Measurement Location

The location of the ambient temperature measurement shall be one inch down from the lamp socket mounting plate and one inch from the inside wall of the luminaire.

6.4 Photometric Measurement Location

The photodetector shall be positioned at nadir (0 degrees vertical) below the luminaire with its measuring surface perpendicular to the path of direct light from the luminaire. It is recommended that the photodetector be secured to a locating device that will allow precise and repeatable positioning of the photodetector.

6.5 Lamp Seasoning

Prior to testing, all lamps must be seasoned for 100 hours in accordance with IESNA-LM-54-99[5].

6.6 Test Procedure

1. Install the lamp in the ambient luminaire within the UL 1598 apparatus. Adjust the lamp position within the luminaire. The lamp shall be centered, and the bottom of the lamp shall be even with the bottom of the luminaire's aperture. Note that the apparatus is operated without insulation or its gasketed lid for this part of the testing.
2. Apply the lamp's nominal rated voltage to the system.
3. Allow the system to reach stabilization. Stabilization is defined in IESNA LM-41-98[6] as follows: The lamp is considered to have reached stabilization when the light output monitored over a 60 minute period does not produce differences of more than 0.5 percent.
4. Record the photometric measurement at nadir.
5. Record the electrical measurements for the system (Volts, Amps, and Watts).
6. Remove power from the system.
7. Install the IC Rated Luminaire and fill the apparatus with loose fill cellulose insulation to the levels specified in UL 1598[4].
8. Apply the lamp's nominal rated voltage to the system.
9. After six hours, record the photometric measurement at nadir.
10. Record the operating temperature within the luminaire.
11. Record the electrical measurements for the system (Volts, Amps, and Watts).
12. Remove power from the system.

6.7 Test Report

The test report shall include at least the following test information:

1. Manufacturer's name and product identification
2. Name of the testing facility
3. Test Date
4. Electrical and photometric readings in ambient conditions.
5. Electrical and photometric readings in the insulated IC Rated Luminaire.
6. The light output ratio between the end-state photometric reading in the ambient environment and the end-state photometric reading in the insulated IC Rated Luminaire (expressed as a percent).
7. The end-state operating temperature within the insulated IC Rated Luminaire.

7.0 Elevated Temperature Testing Apparatus

7.1 Test Environment

The test environment shall be clean and free from large amounts of dust and moisture. The ambient temperature surrounding the Elevated Temperature Testing Apparatus shall be maintained at 25°C ± 5°C. The perimeter of the apparatus shall be kept clear of obstacles so that airflow is not inhibited from entering the apparatus during the purge portion of the test cycle. The operating temperature within the apparatus (represented as the average of at least four measurement locations specified in section 7.3 below) shall be maintained at 55°C ± 5°C during the on-cycle. The operating temperature within the apparatus shall be achieved within one hour upon on-cycle initiation.

7.2 Construction of Apparatus

The interior of the Elevated Temperature Testing Apparatus shall be a flat section of perforated substrate with ceramic lampholders attached in an array. The array of lampholders shall have an equal number of rows and columns. Additionally, the sides of the apparatus shall be equal in length. The perforated substrate shall have holes of a minimum diameter of ¼" spaced at a maximum spacing of 1" on center. The spacing between lampholders shall be no less than 8" on center and no greater than 12" on center. Radiant baffles shall be installed at the mid-point between all lamps and along the perimeter of the lampholder array. The radiant baffles shall be constructed of an opaque, rigid material and shall be a minimum of 10" in height. The four sides and hood of the Elevated Temperature Testing Apparatus shall be sealed and insulated. The insulation shall have a minimum R-value of 14.0. The sides of the apparatus shall extend a minimum of 12" below the bottom of the radiant baffles, and shall have an intake section a minimum of 6" in height below the sides of the apparatus. The slope of the hood of the apparatus shall be at least 30° above horizontal. The top of the hood shall be equipped with an exhaust fan and louver. The exhaust fan shall be thermostatically controlled to maintain the appropriate ambient temperature within the apparatus. The louver shall automatically close when the fan is not operating. See figure 4.

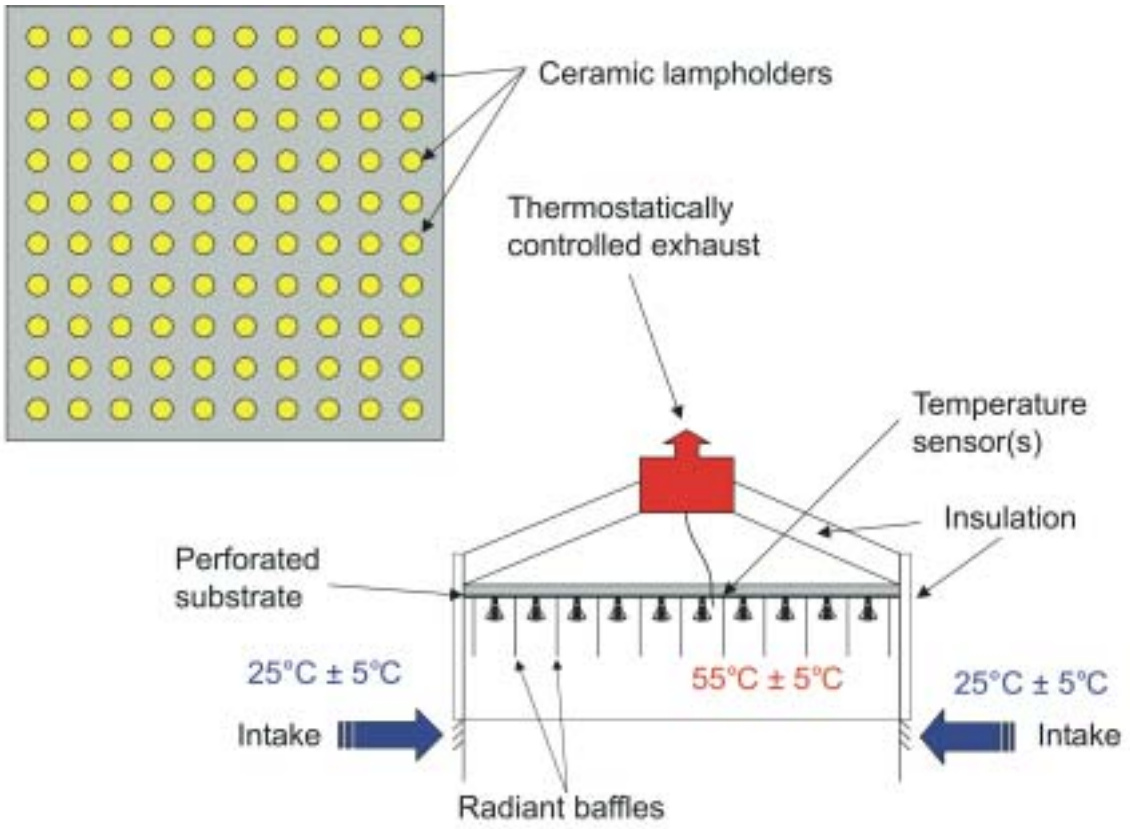

FIGURE 4: DESIGN OF THE ELEVATED TEMPERATURE TESTING APPARATUS

7.3 Temperature Measurement Locations

The apparatus shall be equipped with at least four operating temperature measurement locations. The four operating temperature measurement probes shall be located within the second row of cells from each of the four sides, and in the middle cell (or one of the two middle cells if appropriate) of each side. The location of the temperature probe within the cell shall be one inch down from the perforated substrate, and one inch over from the radiant baffle closest to the exterior of the apparatus. The operating temperature of the apparatus shall be defined as the average of the operating temperature readings within the apparatus.

7.4 Photometric Measurement

The photometric measurement device shall consist of a securely mounted photodetector positioned such that the plane of its detector is horizontal. Sufficient shielding shall be incorporated such that only the light from the lamp under test is measured. This shielding can be accomplished by the use of a flat-black-painted tube that extends from the photodetector to the bottom edge of the radiant baffles. Additionally, it is recommended that a piece of spectrally neutral opal glass or plastic be installed above the photodetector to diminish the sensitivity of the measurement from minor misalignments of the photodetector.

Photometric measurements need to be acquired at a time when the light output of the lamp has reached a steady state. As a result, the photometric measurements shall be acquired at a point at least two hours after the beginning of an on-cycle of the lamps. In the situation where the specified measurement time occurs before the lamp has reached its steady state operating time, the lamp shall be measured at the closest steady state period.

7.5 Operating Cycle

The operating cycle shall be 180 minutes on, 20 minutes off[2]. The operating time of the test lamps shall be accumulated only during the 180-minute on time.

7.6 Lamp Monitoring

The lamps shall be monitored for continued operation at a frequency of once per day. Verification of operation can be accomplished by visual inspection or by an automated procedure. The lamps shall be visually inspected for cracking, discoloration, etc. at least once every two weeks of operation. Any changes in the condition of the lamps shall be noted in the test report.

7.7 Lamp Seasoning

Prior to the first readings, the lamps shall be seasoned for 100 hours in accordance with IESNA-LM-54-99[5]. This seasoning can be accomplished either inside or outside of the test apparatus. If the seasoning is performed outside of the test apparatus, the lamps shall be seasoned for 79 hours before being installed in the test apparatus. The 100-hour readings shall then be acquired when the lamps reach 79 hours plus 21 additional hours inside the apparatus. This will ensure that the lamps have reached equilibrium in their temperature cycle during the lamp operation cycle.

7.8 Test Procedure

1. Season ten lamps according to section 7.6 above.
2. At the 100-hour point, record the photometric measurement for each lamp.
3. Monitor the lamps according to section 7.5 above.
4. At the 1000-hour point, record the photometric measurement for each lamp.
5. Monitor the lamps according to section 7.5 above.
6. At 40% of the lamps' rated life, record the photometric measurement for each lamp.
7. Continue to monitor the lamps according to section 7.5 until rated life is achieved.

7.9 Test Report

The test report shall include at least the following test information:

1. Manufacturer's name and product identification
2. Name of testing facility
3. Test date
4. Photometric measurements at 100 hours, 1,000 hours, and 40% of rated life
5. 1000-hour elevated temperature lumen maintenance (This is calculated as the ratio, expressed as a percentage, of the 1000-hour illuminance measurement to the 100-hour illuminance measurement).
6. 40% of rated life lumen maintenance (This is calculated as the ratio, expressed as a percentage, of the 40% of rated life illuminance measurement to the 100-hour illuminance measurement).
7. Number of hours of operation before failure or note that the lamp reached rated life
8. Notes describing physical condition during testing (cracking, discoloration, etc.)

References

1. IESNA Testing Procedures Committee, Guide for the Selection, Care, and Use of Electrical Instruments in the Photometric Laboratory, IESNA LM-28-89. New York: Illuminating Engineering Society of North America, 1989
2. IESNA Testing Procedures Committee, IESNA Approved Method for Life Testing of Compact Fluorescent Lamps, IESNA LM-65-01. New York: Illuminating Engineering Society of North America, 2001
3. The Basis of Physical Photometry, CIE-18.2, Commission Internationale de l'Eclairage. Vienna: Bureau Central de la CIE.
4. UL 1598
5. IESNA Testing Procedures Committee, IESNA Guide to Lamp Seasoning, IESNA LM-54-99. New York: Illuminating Engineering Society of North America, 1999
6. IESNA Testing Procedures Committee, Approved Method for Photometric Testing of Indoor Fluorescent Luminaires, IESNA LM-41-98. New York: Illuminating Engineering Society of North America, 1998